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Wireless Troubles.

Just what wireless telegraphy is good for, outside of stock-jobbing operations, is probably an unguessed conundrum to many people. This uncertainty is turned to account occasionally by the sharp-witted, like the automobile demonstrator who recently excused the poor ignition of a car he was driving on the ground that wireless experiments were being conducted in the vicinity during that day and all electrical apparatus was more or less affected in consequence. Even Kipling has reported a case where the experimenters

put their apparatus on the roof of a hotel, connecting their batteries with the plumbing, so that the guests were shocked when they took their baths. The recent international congress of representatives of numerous governments, held for the purpose of reaching an agreement concerning the control of wireless telegraphy, was probably the first intimation to many people that this new method of communication was a serious matter. Its commercial usefulness on any considerable scale has yet to be demonstrated, although for some purposes and under some conditions it affords a valuable addition to older methods of long-distance communication. It is not to this aspect of the subject that it is desired to call attention in this place, however, but rather to some of its freaks.

In its aspect as a trouble maker, wireless telegraphy occupies a position which is on the same supernatural plane as a good old-fashioned Southern "hant," such as Uncle Remus tells us about. Imagine, for instance, the feelings of an uneducated servant in a doctor's office who suddenly sees flashes of flame playing about the apparatus in the room where he is employed or hears the Morse code rapped out from the receiver of a telephone. Yet the National Board of Fire Underwriters has recently reported that a wireless station was responsible for these and other troubles in its vicinity. Its sending apparatus was supplied with current by a 7½-kw. pole transformer on the three-wire system, by which a voltage of about 20,000 volts was impressed on the aerial conductors on the mast, and when this equipment was in use breakdowns occurred in lighting and small motor circuits in the neighborhood supplied by other transformers of the same system. In the doctor's office before mentioned, the lamps and apparatus were supplied from a transformer whose secondary line paralleled that leading to the wireless apparatus. As a result of sending messages, plug fuses in the service entrance box were blown out violently and the windings of a small motor were destroyed. This case was remedied by shifting the doctor's service line out of parallelism with the wireless circuit, and the telephone disturbances were remedied by the insertion of suitable capacities in the telephone service circuits.

Another case in which a wireless station spread trouble as well as messages through the air was recently described by Mr. James L. Robinson, of Albany, N. Y. An experimental station of large capacity, using an antenna of wide spread, was established in a building where direct current was used for power and lighting, being supplied from a distance over lines which paralleled other circuits. When the station was equipped the effect of its operations on electrical apparatus in the vicinity was overlooked and no attention paid to the telephone, telegraph and low-potential alternating currents in the neighborhood. After the wireless transmission was begun it was a common thing at first for fuses to blow out in the direct-current circuits, the field coils of motors to burn out, and the life of incandescent lamps to be brought to an untimely end. Telegraph instruments were ruined by their new competitor, even when it was using a long wave with large capacity and small inductance. When the inductance was increased to any extent the apparatus in the neighborhood had very little show whatever. In this case, as in that first mentioned, remedies for the troubles were found after a time.

These troubles were more annoying than serious, but there was one feature of the disturbances which has a dangerous side, the fires started through the influence of the wireless apparatus. Mr. Robinson states that in the case of the station just mentioned small fires were caused by the rush of current following the breaking down of insulation in lamp sockets or at fuses, although only in one instance was serious trouble caused

outside the building containing the apparatus. This was a fire started on account of the very poor insulation and installation of wire in a house using alternating current from a line running near the antenna. Up to a distance of many hundred feet from the station a person could draw static sparks from wires insulated from the ground, although at a distance of 100 ft. these had not power enough to be felt. In view of the enormous fire losses which occur annually it is decidedly disquieting to learn that another and most elusive cause of fire is likely to be found wherever a wireless telegraph station is located. If the presence of such a station renders circuits in the vicinity unsafe which are otherwise safe, it is manifestly desirable to have the subject carefully investigated, and, if practicable, regulations adopted which will minimize the danger.

Steel for Automobiles.

The name of Dr. Leon Guillet is well known to those readers who are interested in the subject of high-grade steel, for his important contributions to the literature of the subject have been widely quoted as authoritative and earned for him recently the distinction of the gold medal of the Iron and Steel Institute. It is probably not so well known, however, that he has long held the position of metallurgist to the De Dion-Bouton firm of French automobile manufacturers, and many of his papers are based on his investigations to determine the proper materials to employ in the construction of motor cars. It is no secret that some of the most interesting recent developments in the line of special steels in the United States are due to the demands of makers of these vehicles, and attention may therefore be called to a valuable paper on the subject contributed to the "Horseless Age" by the eminent French metallurgist. It is particularly interesting as showing the importance attached to technical matters by the prominent firm with which he is associated, and the far greater appreciation in which special steels for high-grade machinery are held in France than here.

The paper is mainly interesting as showing very clearly the advantages offered by such special steels over the ordinary steels, generally due to the fact that by their use the same or better results can be produced with less careful or shorter treatment. For example, in the manufacture of ball races and many other parts from ordinary steel the hardening by the cementation process has to be conducted very carefully in order to secure a product fit for use in a high-grade car. The final result depends on a nice adjustment of five factors, the character of the steel, the nature of the cementing compound, the temperature of the furnace, the time of contact of the steel and cementing material and the heat treatment which follows the cementation. The metal must be one which will not become brittle after quenching. The cementing material must be of uniform known composition so that definite results can be obtained. The temperature of the furnace must be regulated so as to secure the desired depth of hardening, and the time of contact must be fixed with the same object in view. The final heat treatment for the best results is a really delicate operation, as it will not give a core free from brittleness and a very hard outer surface if there is any carelessness shown at any stage in the work. The investigations of Dr. Guillet and others have shown that the use of nickel steels and chrome steels of certain proportions enables the desired results to be attained without such a close attention to temperature conditions, and consequently insures a product of a more uniform character.

Another instance of the value of these special steels is afforded by the valves. If these parts are made of soft steel, as is often the case in

this country, they are worn away very rapidly by the gases, and consequently special steels have been developed for them in France. One is interesting as containing the iron in a special state, the gamma iron of M. Osmond; it has 0.2 per cent. of carbon and 30 to 32 per cent. of nickel. It is normally a very difficult metal to machine, but by quenching it at 1,000° the working is greatly facilitated. This alloy is particularly important because care in the cooling of the cemented pieces will do away with the necessity of many of the stages of manipulation required in making really good valves of ordinary steel. There are other alloys, such as some of the chrome-nickel steels, which are useful for the same purpose, while some grades of the manganese steels introduced by Mr. Hadfield have been found very desirable for valve seats, the objection to them being the necessity of shaping them by grinding instead of machining, owing to their extreme hardness. Silicon steel has been found to be particularly useful for leaf springs and gears, when properly manipulated. Regarding vanadium steels, M. Guillet has very little to say on account of their scarcity and the secrecy maintained concerning them, but he is evidently inclined to find them useful. Their main advantage is the simplicity of their treatment, for they need merely quenching in water without reheating. When so manipulated they offer a considerable resistance to shock and have a high tensile strength and elastic limit. Their drawback is the necessity of annealing them, for when they come from the forges they are more brittle than other steels.

Mention is made in this brief way of a very few of the special steels which are made commercially to-day in France mainly on account of the demands of builders of high-grade automobiles. While it is true that research work in metallurgy is gradually pushing back the line of our ignorance concerning special steels, the recognition of the fact that the best metal it was possible to obtain was none too good for the best automobiles, has unquestionably done more to increase the definite information concerning these metals than all the investigations of independent laboratories. When the scientific ability of a technical specialist is reinforced by the resources of a wealthy and influential manufacturer the conditions are most favorable for rapid progress in new lines of research, and it is for this reason that metallurgy must to-day give thanks to the automobile industry for real progress along some most interesting lines.

Trade Relations With South America.

Inasmuch as many of the readers of The Engineering Record have been endeavoring for some years to establish better business relations with South American nations, this journal has let pass no opportunity for obtaining and printing information on the subject. It has all been to the same effect, however, that the tastes of the customers rather than those of the manufacturers must be suited, the business methods of South America rather than those of the United States must be observed, particularly in the matter of credits, and the business must be assisted by having resident representatives who will enter into the social life of the cities where they live and acquire the local viewpoint. This has been repeated from time to time in The Engineering Record, until it seemed hardly necessary to say it more than about once a year, and it is all the advice Secretary Root has to offer as a result of his visit to South America. If the nations of Europe are taking possession of the foreign business of the countries to the south of us, it is manifestly because of definite causes. These may be divided into two classes, one the result of immigration, and the other of

trade methods. We have been giving a home to so many immigrants from Europe that we have overlooked the fact of a similar immigration into South America. It has been taking place, however, and an excellent class of people has been bringing into that continent the knowledge of European business methods and products, which is largely unknown with us, or is ridiculed if it is known. Those methods are more like South American procedure than are our own. This large and influential population recently acquired from Europe has had nothing to counteract it in the shape of a similar immigration from the United States, and as a result our relations with the republics to the south have been almost wholly political. As Mr. Root pointed out in a masterly address before the Trans-Mississippi Commercial Congress on Nov. 20, the utilization of the opportunities of South American trade must be accomplished by a multitude of individual efforts and not by government action, and European nations have a long start over us on account of the emigration from them to our sister republics.

The usual attempt made by the American machinery manufacturer to force on his foreign customers what he likes, regardless of their own views, is strongly criticized in Mr. Root's address. If they think they need heavy castings, the manufacturer should give them heavy castings instead of the light ones he considers better. The tendency to standardize articles of manufacture may reduce their cost and promote convenience, but if the consumers on the River Platte demand a different standard from that of the consumers on the Mississippi, it is necessary to adopt two standards or lose one market. Again, the system of credits must be modified as before mentioned, otherwise customers will be insulted by requests to conform with what are ordinary business methods with us but are regarded by them as reflections on their commercial integrity. Business men in South America have their own ways of transacting their affairs. They have to adapt the credits they receive to the credits they are compelled to give; it is often inconvenient and sometimes impossible for them to conform to our ways, and the requirement that they should do so is a serious obstacle to the extension of our trade. This subject suggests that of banking, for the bank is the best source of information concerning business accommodations adapted to the locality where it is located. Consequently banks under American control are very desirable in South America. Mr. Root states that nothing but very bad management could prevent such institutions from making money, because the rapid development of South America renders capital very desirable. American banks would relieve American business in South America from the disadvantage which now exists of making all its financial transactions through Europe instead of directly with the United States. Mr. Root states it is unfortunately true that, among hundreds of thousands of possible customers, the United States now stands in a position of assumed financial and business inferiority to the countries through whose banking houses all its business has to be done.

It is unnecessary in this place to take up the broader features of this important subject of trade with South America, not only because they are not of immediate usefulness to the readers of The Engineering Record, but also because they are discussed in detail in the address of the Secretary of State. They relate to the investment of American capital under American management in South America, and the establishment of better lines of communication with that continent. The first is a matter of finance, and the second is one in which our shipping laws play a leading part. Even without the help of

improvements along these two lines, a great deal can be accomplished by an observance of the suggestions first made, which, although not new, gain added importance from the confirmation they have received from Mr. Root.

The Timber Tests of the Department of Agriculture.

The physical and mechanical investigations of native timber of the Forest Service of the U. S. Department of Agriculture during the past ten or twelve years have been of great value in many respects but defective for engineering purposes in other respects. These investigations have resulted in a great mass of data embodied in the various circulars of the Forestry service and have thus become available to engineers and others interested in the timber products of the country. The mechanical investigations, it will be remembered, were conducted largely by the late Professor J. B. Johnson, who inaugurated and pursued this part of the work of the Forestry service with characteristic thoroughness and excellence. The range of timbers covered by these earlier investigations was wide and the classes of tests were sufficient in number to disclose much interesting and important technical information regarding the physical and mechanical properties of most of the structural timbers of native growth. There were, however, some defects in the interpretation of the results of the mechanical tests. The results were issued with the authority of the Forestry service and some erroneous conclusions were reached which, if accepted by engineers, would result in bad design.

Nothing is more clearly established than the wide diversity of resisting capacity exhibited in the tests of small and large pieces of timber or between full-size merchantable pieces as ordinarily delivered for engineering structures and the same size pieces selected for physical and mechanical investigations or held under conditions which give perfect seasoning. The older tests of the Forestry service were made without full regard to all these essential conditions. Every experienced engineer is aware, and sometimes painfully so, of the weakening defects of small knots and other physical conditions which he frequently cannot control even under the best specifications. Whatever may be the degree of care exercised in applying the prescribed conditions of acceptance, a large proportion of the timber which he must take for his purpose is far from being of the same quality as that of the selected pieces taken by the Forestry service for its purposes of investigation. Commercial timber of the best grades even is one thing and the selected material taken for the tests of the Forestry service is quite another.

While these considerations indicate the sources of high test results in full-size pieces there was a source of still greater and more serious error in a practical application of the conclusions embodied in the older circulars issued by the Bureau of Forestry. If one will take the trouble to refer to these older records it will be found that the bending tests of small test pieces cut from selected sticks were considered to be accurately representative of the results to be found from the testing of full-size sticks. This would be an erroneous assumption in designing timber beams for carrying either the comparatively quiescent loads of buildings or the rapidly moving loads of railway trains. It is a serious error to assume that the working fiber stress in beams built of commercial timber can be inferred with any closeness from the tests of such small selected test pieces. These matters have been pointed out before, but it is well to remember them in view of "Instructions to Engineers of Timber Tests" in Circular 38, issued

by Prof. W. Kendrick Hatt, the civil engineer of the Forestry service.

It is gratifying to observe that the older errors apparently will be largely and possibly entirely eliminated in the work now to be done. These instructions include the following paragraph at their very beginning: "Tests of the mechanical and physical properties of timber in forms found on the market. The material will be of actual sizes and grades in commercial use. The purpose is to determine the moduli for design; to determine the value of woods now considered inferior; to determine the liability to knots and the equivalent reducing factors; . . ." If such provisions really govern the tests to be made the results will be of far more value than any which have hitherto been reached. Obviously such conditions ought to control all mechanical testing of timbers. It is not only necessary to determine the amount of moisture in full-size test pieces and other physical conditions, all of which are provided for in Professor Hatt's instructions, but also to make series of tests of just such pieces in the same commercial conditions which the engineer meets in his structural work. There are probably more erroneous tabulated results of tests of timber extant in engineering books than in connection with any other material used for structural purposes, and it is all due to this failure to recognize both the radical difference in the qualities of commercial timber and that selected for purpose of investigation, and the equally great or greater differences in the results of tests of small pieces and of full-size sticks.

There are other mechanical properties of timber which ought also to be fully investigated by the Forestry service, most of which are covered, fortunately, by Professor Hatt's instructions, but others are not. Although much is known regarding the failure by longitudinal shear of comparatively short timber beams, more of distinct value would be disclosed by suitable full-size tests, and it is hoped that these investigations will be extended far enough to accomplish this result. If practicable to make such a determination it would be of much value to engineers to know approximately where failure by this shearing ends and failure by the clear rupture of extreme fibres begins in the ordinary commercial timber beam. The answer to such a question obviously involves a large number of tests of various kinds of timber, but the expense and time incurred after all are small in view of the value of the results obtained.

Again tensile tests of pieces of timber of reasonable size of the same kind and quality as those from which beams are taken are much needed both for the results in themselves and for comparison with the fibre stresses developed in beams tested to failure. Engineering literature is practically devoid of all such data. There are tensile tests in some number of small selected pieces, but the results are so high as to be of no real value; in fact they are worse than valueless because they mislead the inexperienced. Finally there are yet many open questions regarding the mechanical or resisting qualities of treated timbers including the effects of various preservative processes in use. These are contemplated in the work before the Forestry service, but the value of the investigations will depend entirely upon the extent to which they are carried and the intelligence and thoroughness with which they are conducted. It is earnestly hoped that all this work may be extended and shaped or controlled from time to time in the light of accumulated experience with full-size testing as it may be developed and with the actual conditions of engineering design and maintenance fully in view. It is particularly important to secure this information regarding the timbers hitherto regarded as of inferior quality.

The Greatest Tunnel.

There is something about the revival of the project to construct a tunnel between Great Britain and France which is specially pleasing to anybody of an engineering turn of mind. The linking together of these two countries by a pair of little tubes under the often-troubled waters of the Channel should go a long way towards smoothing the often-strained relations between two nations which should be fast friends. Americans, accustomed to traveling long distances without thinking they are doing anything unusual, cannot appreciate what a barrier exists between France and England in the narrow strip of green sea that intervenes. If this barrier can be broken down, so that it is easier for the two peoples to become acquainted without suffering the pangs of seasickness, then engineering will have taken its place as a potent instrument of diplomacy. In fact, the Channel tunnel would probably have been serving its friendly mission long before this, for it was not beyond the engineering resources of a quarter of a century ago, but for the ridiculous fear that it would afford a ready means for a hostile invasion of England from the Continent. In whatever light it is viewed, the project seems a feasible one, much more so than the bridge across the Channel which was advocated about seventeen years ago by British interests and the Creusot and Hersent companies. Statistics show that commercial relations between France and the countries to the north are increasing much more rapidly than between France and Great Britain, which is largely due to the better communication with Belgium and Germany. Just how far the dreaded Channel trip accounts for the lack of personal business travel which must precede the heavy shipment of merchandise it is hard to say, but those who are acquainted with the aversion shown to a few hours on a Channel steamer by most French and British people will rate this feeling as a considerable factor in the relatively slow growth of the business relations of the two countries.

The tunnel project is by no means a new one, for it was seriously investigated a century ago by a mining engineer who submitted plans for the work to Napoleon. About sixty years later M. de Gamond spent many years making investigations and studies which resulted in plans shown at the Paris Exposition of 1867. These attracted much attention, and a discussion of them was undertaken by the diplomatic representatives of the two countries. In 1875 a French company was formed to conduct the necessary examinations and preliminary work, and was granted a concession for ninety-nine years from the time the railway was in working condition. It entered upon this work with much energy and accomplished a great deal in the way of determining the geological conditions along the route of the tunnel, which were shown to present no serious difficulties. All this work was of no avail, however, for the British government absolutely refused about thirteen years ago to give its sanction to any tunnel connection between the countries. The marked friendly relations of the two nations during recent years have again led to a revival of the company's plans, and a new attempt will be made to secure the assent of the British authorities for the execution of the work.

While the diplomatic difficulties have been serious as yet, all the investigations and preliminary excavations have been decidedly favorable to the work. The bed of the Channel along the route of the tunnel is apparently an ideal material in which to conduct tunneling operations. In the course of the work done prior to the closing down of operations in 1883, a tunnel 7 ft. in diameter was driven 5,521 ft. in a period of eight and a half months by Col. Beaumont's tunneling

machine; the total length of this tunnel was 6,033 ft. and its finished diameter was 14 ft. A similar machine was used on the British shore in driving a tunnel 5,905 ft. long, about nine-tenths of it being under the Channel. Since that time there has been a great advance in methods of tunneling, and it is interesting to note that the plans now proposed for the work by M. Breton, the company's director, contemplate a modification of the system used so successfully on the Simplon work. He proposes to construct two twin tubes 20 ft. in diameter and 50 ft. apart for traffic, and a smaller tunnel 10 ft. in diameter and on a different grade line and alignment for drainage purposes and to afford additional facilities for construction purposes. It is the intention to use this small tunnel for a service railway for men and materials and to connect it by shafts with the main tunnels, so that operations can be conducted in both directions from the ends of these rising shafts just as they are from the bottoms of shafts sunk from the ground level in ordinary tunneling operations. Whether this method of working will be finally approved must, with other technical details, be left for future decision. The total length of the tunnel route, including the land tunnels, is 34.4 miles. After the shore shafts are sunk it is estimated that the work of tunneling can be completed in seven years.

In view of the tunneling feats accomplished in this country in material probably much more difficult to manage and the successful construction of tunnels elsewhere, it would seem that the practicability of the project must be settled largely on financial and diplomatic considerations. It is true that the ventilation of such tunnel workings presents some interesting problems, but these are probably not so difficult of solution as the handling of men and materials. It is doubtful if a shift could work over six hours a day with efficiency, which will render a large force necessary, while the removal of 4,000 tons of spoil daily, necessary to complete the work in the time mentioned, will call for railway facilities and methods of operation of an unusual nature. It is understood that the chances of securing British permission to go ahead with the work are considered about even at present, and we accordingly have grounds for anticipating the early beginning of this greatest of tunneling undertakings. Whether the permission is given now or not, it seems safe to say that the increased closeness of relations between Great Britain and France and the progress in engineering resources will eventually bring about the construction of this important work.

THE GLOVER SEWAGE DISPOSAL PATENTS have again been declared not to cover the septic principle of treatment. In the first decision of the U. S. Circuit Court, two years ago, it was stated that nothing in the inventor's applications indicated that Glover knew what septic action in sewage was or intended to cover any such method of treatment by his patents. After that decision was rendered, a petition to reopen the case was made to the Circuit Court of Appeals on the ground that the court did not recognize present scientific opinions concerning septic tanks. This petition has been rejected by the court on the ground that, even if the state of the art in all its detail was not fully recognized, no new facts have been introduced to change the validity of the distinction drawn between sedimentation and septic tanks. The court rules that Glover did not show any knowledge of this distinction, according to the record of the case. This ruling is of interest because of its general bearing on the subject of sewage disposal, for if the patents were held to cover septic tanks, with or without filtration of the septic sewage, they would give a monopoly of several useful methods of disposal to their fortunate owners. The full decision is given in this week's Supplement.

SOME STRUCTURAL FEATURES OF THE CITY INVESTING COMPANY'S BUILDING, NEW YORK.

NOTES CONCERNING A THIRTY-TWO-STORY BUILDING RISING TO A HEIGHT OF 486 FT. ABOVE THE SIDEWALK.

Work has been commenced on the construction of another very large building near the Wall St. district, New York, which, although not quite as tall as the Singer building tower adjoining it, will attain an extreme height of 486 ft. above the sidewalk and will have 32 stories, thus making it taller than any other office building yet completed. As it was impossible to secure the whole of the rectangle it partially occupies, the building has been designed with an irregular shape enclosing, at the corner of Broadway and Cortlandt St., the six-story Benedict building about 56½ ft. wide and 106 ft. long, thus securing for itself fronts of about 37½ ft. on Broadway, 209 ft. on Cortlandt St. and 105½ ft. on Trinity Place. An unusual feature in the plan is the location of the 40x65-ft. light court in the middle of the Cortlandt St. front, thus forming a deep recess in the face of the building that structurally separates it above the third story into two wings and admits light and air well into the interior of the building much more effectively than could be accomplished by a high court of the same dimensions adjacent to the party wall of another building, enclosing it on all sides. This arrangement lends itself satisfactorily to the location of the main corridor, elevators and stair shafts which occupy most of the extension on the long side of the building directly opposite and thus secures an attractive and economical arrangement of floor space. This amounts to about 500,000 sq. ft. of rentable area and corresponds with a cubical contents of 10,300,000 ft. The exterior walls will be of stone to the sixth floor and above that of special brick with terra cotta trimmings. They will be comparatively plain and dignified, giving the impression of enormous mass from the harmonious proportions of vertical and horizontal dimensions, which are so unusual in the majority of tall office buildings.

The four lower stories, each of unusual height, will be capped by a powerful cornice which will be at the level of the roof of the present Benedict building and will form an arrangement, combined with the difference in the appearance of the stone below and the brick above, which will give the effect of a massive pedestal from which the main shaft of the building rises. In these bays, on each street, there will be an entrance to the elevator halls. That on Broadway, the principal entrance, will be a large semi-circular-headed opening leading directly into the vestibule and barrel-vaulted arcade. Above the main entrance on Broadway the façade takes the form of a tower at the twenty-fifth story, having large openings with engaged columns topped with a belvedere in the middle. In the portion on Cortlandt St. the façade will be divided into two main pavilions running to a height of 25 stories, treated to harmonize with the Broadway elevation. The center recessed portion between these two portions will be carried up to a height of 32 stories above Broadway, with a high-pitched copper roof and ornate gables, making at once a powerful and picturesque sky line. Except for the single windows in the rounded corners of the Cortlandt St. wings, all of the windows are arranged in groups of two or three giving regularity to the high walls which are further diversified by occasional belt courses and balconies. The architectural motive of the lower part of the building is the arcade, which extends 304 ft. through the entire length of the building from Broadway to Trinity Place, having at each end arched portals for the main entrances. The entire arcade will be on a magnificent scale, being 32 ft. wide,

and 40 ft. in height throughout. The three groups of elevators are set in alcoves off the main arcade. The design provides elaborate frescoes in the barrel vault which forms the suspended ceiling.

The total estimated weight of the building, exclusive of live load, is 86,000 tons, which will be carried on columns placed on the top of the grill-

in six longitudinal rows so as to provide uniform floor panels of somewhat exceptional dimensions, all of them having a length of 23 ft. and a width of from 19 to 25 ft. The maximum column load is 1719 tons, requiring a cross-section of 253.6 sq. in. which is built up with fourteen plates and four angles. The columns are seated on cast-steel pedestals transmitting their loads through distributing girders and grillage, which reduce it to the permissible pressure allowed by the building regulations. The great concentrated loads necessitate unusually large foundation girders, several of which are triple-web 90-ton girders, 9 ft. high, 37 ft. long and 60 in. wide, which will



General View of City Investing Company's Building.

lage of the concrete piers sunk by the pneumatic process to rock at a depth of about 80 ft. below the Broadway curb. The main excavation will be carried about 30 ft. below the Broadway curb to accommodate the basement, which, with the extension under the sidewalk, will have an area of about 32,000 sq. ft.

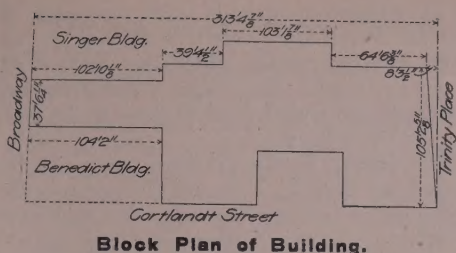
The superstructure will be of steel-cage construction supporting the walls from the columns at every story. There are 89 columns on each floor, in two to three-story lengths, which have been arranged with special reference to regularity

be delivered at the site in three separate portions to be assembled in position. Provision will be made for waterproofing the column bases with lead pans, and devices which will insure their insulation against possible electrolytic action will be employed.

Wind pressure and floor loads are assumed in accordance with the building regulations and stresses produced by the former will be absorbed by the inertia of the building, the resistance of its cross walls, and the depth of the rigid beam and girder connections. The floors will be of hol-

low tile flat-arch or concrete construction with cinder filling and mosaic or terrazzo surface, and the columns and such girders as project beyond the floor construction will be fireproofed with hollow tile. Particular pains will be taken to run the vertical lines of pipes independent of the column jackets by enclosing them in special chases. All the steel work will be fireproofed and the window sash and frames will be of metal, those overlooking adjacent buildings will be glazed with wire glass.

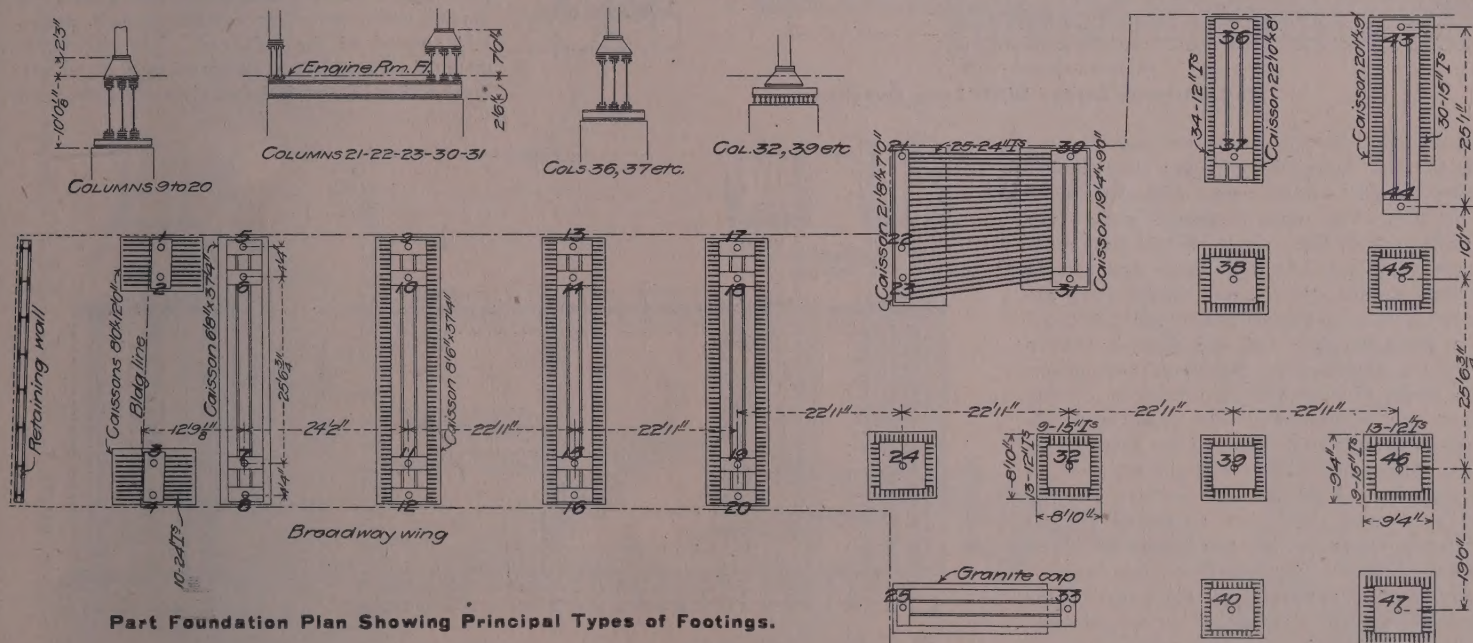
The mechanical installation will have a 2,000-h.-p. boiler plant. Water will be stored in two main tanks with capacities of 12,500 and 9,000 gal., one of them being located half way down to the street level so as to divide the distribution into the stages and to reduce the maximum pressure to about 100 lb. per square inch. The larger tank will be available for gravity supply in case of fire and the usual standpipe, hose and reel, and siamese connections for fire engines will be provided for fire protection. Besides the two sidewalk elevators, there are twenty-one main passenger elevators arranged in three groups opposite the corridors in the rear of the building and occupying nearly all of the extension on the long side. The central group of seven elevators is arranged in arc form and will run local from the



Block Plan of Building.

ments of the building code. The 32d story wall on the south side of the building is 12 in. in thickness down to the 21st floor, 16 in. to the 20th floor, 20 in. to the 15th floor, 24 in. to the 10th floor, 28 in. to the fifth floor to 32 in. to the footings. An adjacent wall has substantially the same dimensions down to the first floor, where it is increased to 36 in. The thickest wall is 32 in. thick at the first floor, and two walls, respectively 28 and 32 in. thick at the bottom, are carried on the third floor girders and extend to the 27th and 32nd floors respectively. The thicknesses of these walls are proportioned strictly in accordance with the building code which requires increased dimensions corresponding to the height of the wall notwithstanding that it serves merely to enclose the building without carrying weight

and the remainder 8 ft. 6 in. wide, and all of them extending across the full width of the wing to receive the column loads through unusually large distributing girders. The pair of double columns, 1, 2, 3, 4, in the Broadway face wall are carried on separate 8x12-ft. piers without distributing girders. A group of three basement columns, 64, 94, 95, in the rear of the building have comparatively light loads and are supported on a 6½x32-ft. pier capped with two separate granite slabs 20 in. thick. One of them, 13½ ft. long, receives its load through a group of seven 24-in. I-beams 12 ft. 10 in. long, which distribute the loads from two columns seated at opposite ends. The other slab 6 ft. 8 in. square is loaded by a single column in the center, the three columns being arranged symmetrically with the center of gravity of the pier. In one corner of the building, five columns, 21, 22, 23, 30, 31, are carried on two piers with an arrangement of grillage beams and distributing girders equalizing the loads and moments due to very irregular spacing of the columns. Three columns and one wall are supported on a triple-web girder placed eccentric with its pier so that the edge of the girder practically coincides with the outer face of the pier and the building line. The remaining two columns are supported on another triple-web girder



Part Foundation Plan Showing Principal Types of Footings.

first to the ninth floor. One of the side groups of seven arranged in a straight line along the face of the rear wall will run express to the ninth floor, and local above to the seventeenth floor, while the remaining seven, symmetrically located on the opposite side of the central group, will run express to the seventeenth floor and local above to the twenty-fifth floor. The central portion of the building, which rises seven stories higher, will be provided with a special elevator service from the twenty-fifth story. The building will contain about 12,000 tons of structural steel and will cost about \$7,000,000 exclusive of the site, which will bring the total expenditure up to about \$10,000,000.

The general excavation for this building will be comparatively shallow, the basement floor level, the deepest part, being only 22 ft. from curb level to the boiler room floor. The basement is carried under the sidewalk on the street sides of the building and the retaining walls are made with concrete slabs reinforced by 12-in. and 15-in. I-beams spaced about 5 ft. apart, with their upper ends connected to 12-in. and 15-in. channels with horizontal webs. The thickness of the exterior walls varies from 32 to 20 in. at the top and is increased downwards according to the require-

and is supported by the steel framework at every floor.

The columns are supported on 58 rectangular caissons located as shown in the foundation plan and arranged as far as possible to carry single columns. Those in the interior of the building are from 6 ft. to 9 ft. 4 in. square, and are centrally loaded by the columns. The wall columns adjacent to neighboring buildings are necessarily located as close as possible to the party lines and therefore are eccentric from the centers of gravity of their piers. In order to load the piers symmetrically, the usual expedient is adopted of supporting these columns on the ends of cantilever girders that carry interior columns at the opposite ends and are provided with symmetrical bearings on the piers. These girders serve as both distributing and cantilever girders and in some instances overhang the piers at one end. Thirteen such girders are used in the main part of the building and are from about 20 to 30 ft. in length with maximum clear overhangs of 7 ft.

The Broadway wing is only 37½ ft. wide and has, in the high lower stories, a row of double columns on each side but no interior columns. Eight of these columns are supported in pairs on piers 37 ft. 4 in. long, one 6 ft. 8 in. wide

that is similarly seated unsymmetrically on the opposite side of the other pier. Between the girders and the piers, there is a set of twenty-five 24-in. 100-lb. I-beams with their top and bottom flanges each reinforced by two 8x9/16-in. full-length plates. These beams are about 26 ft. long and are continuous from out to out of both piers, covering the space between them and acting as double cantilevers to receive the eccentric girder loads and distribute them uniformly over the area of both piers.

Six of the distributing girders for the columns on the south side of the building are very heavily loaded and are supported on 12-in. or 15-in. transverse grillage beams set close together and distributing the loads over the tops of the piers. The remaining distributing girders in the main part of the building have smaller loads and transmit them directly to granite slabs 16 or 20 in. thick which cover the tops of the piers instead of grillage beams. The larger intermediate square piers are all capped with two tiers of 12 or 15-in. I-beams concentric with the column pedestals. A few piers 6 ft. square are capped with single granite slabs 16 in. thick.

Three of the large piers in the Broadway wing have grillages of fifty-five 12-in. transverse I-

beams 8 ft. long and 8 in. apart on centers on which the distributing girders are seated. The fourth pier is narrower and has a lighter load so that the grillage beams are omitted and the pier is capped with a granite slab 16 in. thick which receives the distributing girders. All grillage beams are bolted together with pairs of $\frac{3}{4}$ -in. bolts and gaspipe separators about 4 ft. apart. Great care is taken to set them exactly level at the required height and the lower flanges are grouted and the interstices between them are filled with concrete, which is extended to form a protection 4 in. in minimum thickness which entirely encloses them and the distributing girders above them.

Girder 21-23 is unlike the rest of the distributing

is about 40,000 to 70,000 lb. The rivet heads in the top flanges are countersunk to clear the hot pressed $\frac{3}{4}$ -in. bearing plates that receive the column pedestals. The design of this girder and its details are typical of all of those in the main part of the building.

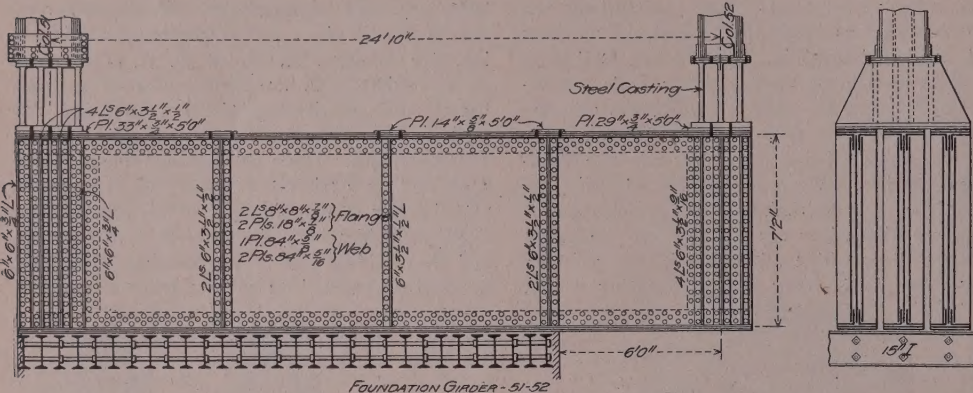
The girders in the Broadway wing are the largest and heaviest in the building and their dimensions are greater than have often been constructed previously. Girders 9-12, 13-16 and 17-20 are duplicates, each of them carrying a total load of about 4,350 tons, which develops a maximum bending moment of 13,500 ft. tons. It is about 37 ft. long, 5 ft. wide and 8 ft. 8 in. deep over all and weighs about 105 tons. Like the other distributing girders it is made up of three

Hedden Construction Co., and the contract for the pneumatic caisson work has been awarded to the O'Rourke Engineering Construction Co. The old buildings formerly occupying the site are being removed, preliminaries for the caisson sinking are under way, and it is expected that the building will be ready for occupancy in the early part of 1908.

A Well-Arranged Pipe Yard.

At the West 21st St. yard of the Continental Asphalt Paving Co., in New York, there is a very efficient system for handling the cast-iron pipes, hydrants and specials that are being used in the construction of the pipe lines of the new high-pressure water system of New York for which work the company has the contract.

The yard is about 220x125 ft. Its long way is parallel to the river and a bulkhead extends the entire length of the yard on the west or river side, thus giving room for two boats to unload at once. The decks of the barges are loaded with pipe of various sizes and the holds are filled with specials and fittings. These pieces must be arranged in the yard in an orderly manner and the unloading must progress so that the boat will be kept level. This is accomplished with a traveling derrick which moves on a track of 20-ft. gauge, laid parallel to the bulkhead. The derrick is mounted on a platform, supported on four wheels, and consists of a 50-ft. boom pivoted on the front

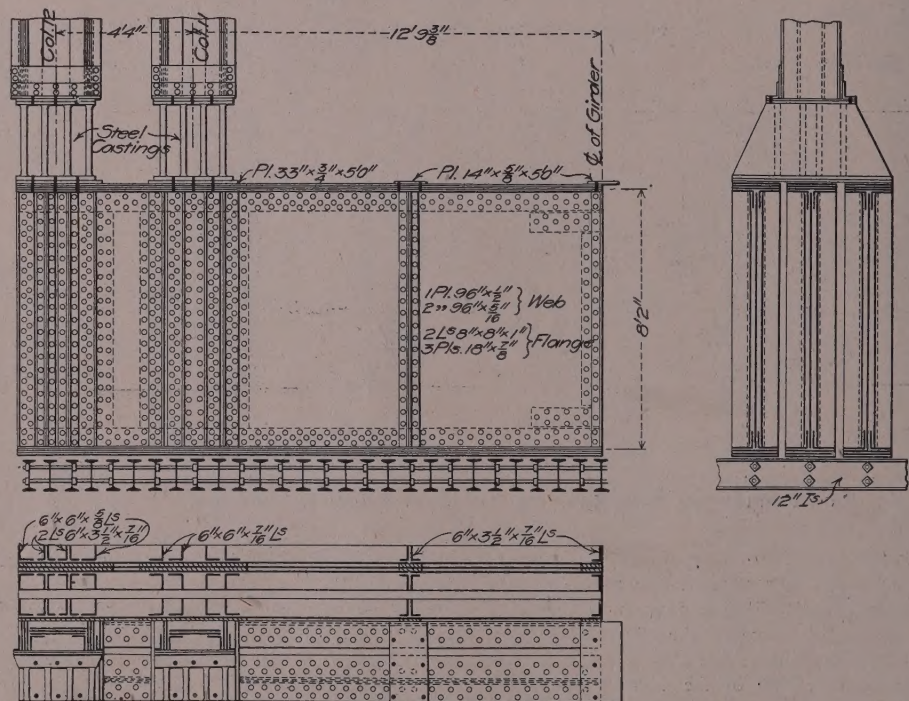


Cantilever Girder With Long Overhang.

girders in that its three webs are united by the wide top and bottom flange cover plates and it is shop-riveted to make a unit shipped complete to the site. The other triple-web girders are in reality sets of three single parallel plate girders connected only by the tie plates and column pedestals on their top flanges. Girder 21-23 has two 60x $\frac{1}{2}$ -in. outside web plates each reinforced by a 60x $\frac{3}{8}$ -in. plate and one 60x $\frac{3}{8}$ -in. center web plate reinforced by two 60x $\frac{5}{16}$ -in. plates. Each flange is made with two 6x $\frac{7}{8}$ -in. outside angles, two 6x4x9/16-in. inside angles and two 24x $\frac{5}{8}$ -in. cover plates. Each of the three pieces of the corresponding triple-web girders, 30-31, at the opposite end of the same grillage is made with a 51x $\frac{5}{8}$ -in. web plate reinforced by two 51x $\frac{5}{16}$ -in. plates and has two 8x8x $\frac{7}{8}$ -in. angles and two 18x $\frac{5}{8}$ -in. cover plates in each flange.

Girders 36-37 are typical of the girders without overhangs which are seated on the grillages. Each of the three members has a 57x $\frac{5}{8}$ -in. web plate reinforced by two 57x $\frac{5}{16}$ -in. plates and each flange is made with two 8x8x $\frac{7}{8}$ -in. angles and two 8x18-in. cover plates. The other girders of the same type are made with webs 57 in. deep or 63 in. deep as required. Girders 43-44 and 51-52 are the heaviest of the overhanging girders and are made as shown in the detail in three separate units. Each of them has a center web $\frac{5}{8}$ -in. thick reinforced by two $\frac{5}{16}$ -in. web plates riveted over the outsides of the vertical legs of the flange angles. The plates are all of the same width and length so that the punching is duplicated in them, and the clearance necessary to permit the outer plates to fit between the flange angles gives an unusually wide clearance between the center plates and the backs of the flange angles.

The plates are not riveted together, except through the vertical stiffeners where filler plates are put in, making additional reinforcement almost equivalent to short columns. The ends of the girders are reinforced by sets of vertical angles covering the full width of the column pedestal and proportioned to transmit the shear from maximum loading. Intermediately between them, the webs are reinforced by vertical angles which, as in all other foundation girders, are spaced about 5 ft. apart. The weight of each girder unit



Half of Foundation Girder in Broadway Wing.

separate units, each weighing 35 tons, independent of each other except as the column loads are distributed equally across them by wide steel pedestal castings bolted to their top flanges.

The lower heads of the rivets in the bottom flanges are flattened and the girders are wedged up $\frac{3}{4}$ in. above the top flanges of the grillage beams to provide clearance for them, the bearing being provided by grout poured under and between the girders until it flushes over the bottom flanges.

Mr. Francis H. Kimball is the architect, Messrs. Weiskopf & Stern are the consulting engineers for the steel construction, Messrs. Griggs & Holbrook, consulting engineers for steam and electricity, and Mr. Wm. C. Tucker, consulting sanitary engineer. The general contract has been awarded to the

of the platform, a pair of shear legs and the necessary tackle. The boiler and engine are carried on the platform. The derrick is moved along the track with a tackle operated by the engine. From one position the derrick can reach any part of the deck of a barge, and any one of four piles of pipe. It has a capacity of ten tons, but the heaviest load applied is three tons, the weight of one 12-ft. length of 24-in. pipe. The pipes are placed parallel to the bulkhead in piles which extend in a direction perpendicular to the bulkhead. Two lines of 4x6-in. timbers are laid along the top of every tier of pipe before another tier is added.

The teams, with which the pipe is hauled away, are driven in on a stone block pavement, laid between the rails of the derrick track, and the trucks are loaded there by means of the derrick. To facili-

tate moving the pipes from the back of the piles toward the derrick, the yard has been graded with a slight slope toward the river. Sometimes the pipes are transferred directly from the barge to the trucks.

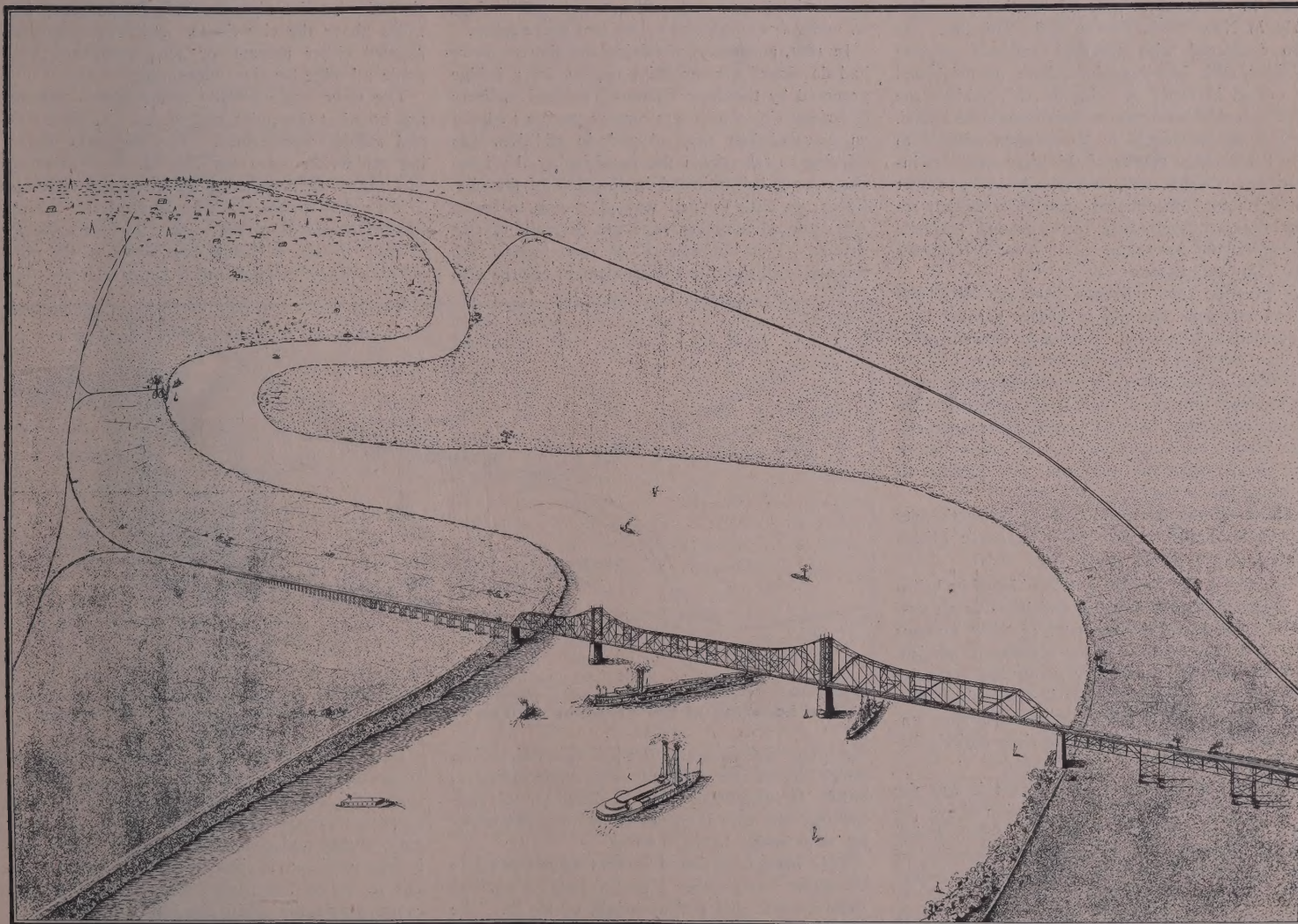
Parallel to the derrick track, throughout its length and just outside its east rail, is a 24-in. gauge track which also crosses the north end of the yard. A push car, which runs on this track, is used for moving specials and fittings to and from the north end of the yard where all these odd pieces are stored. The lighter specials are taken from the car by hand and the heavier ones with a hand-power guyed derrick. The former are placed where they can be loaded on wagons by hand and the latter are grouped within reach of the guyed derrick and when needed are loaded

The New Orleans Railway Bridge.—I.

By Elmer L. Corthell, Director and Chief Engineer, Southern Bridge & Railway Co.

The following communication upon the New Orleans bridge covers the physical, commercial and historical features of a project for a railroad bridge over the Mississippi River, that had its inception in 1888. The writer had been asked to examine the general subject by Major A. C. Landry, chairman of Committee on Streets and Landings, of New Orleans, in a letter dated Nov. 29, 1888. In that letter Major Landry requested the writer to furnish him with such information as would enable him to present to his committee and the City Council a comprehensive plan for a belt railroad, union depot and bridge across the Missis-

of cars from one road to the other in transfer was traced out and the delays, whether seen by himself or related to him by the railroad officials and others, were carefully looked into to ascertain the cause. He mapped out and examined on the ground the position of the tracks from the New Orleans & Northeastern terminus to Louisiana Ave, in order to ascertain if it were feasible to rearrange the very complicated network of tracks existing at several points so as to permit a belt railroad to be laid along the river front without interfering materially with the existing tracks and business of the various roads along the river and into and out of their local freight houses, freight yards, cotton platforms, sugar warehouses and other industries which depend upon the railroads handling their business.



General Sketch of the Proposed Double-Track Railroad Bridge Over the Mississippi River Above New Orleans.

on the car and pushed out where the large derrick can reach them.

These arrangements have made it possible to keep on hand a large and well-assorted stock of pipe, specials and fittings and to handle the same at a cost very much below that usually estimated for such work. The yard is in charge of Mr. R. J. Hicks.

A TENDENCY TOWARD LONGER RAILROAD TIES to provide for heavy rolling stock was shown by the discussions at the recent convention of the Roadmasters and Maintenance of Way Association, at which the 9-ft. tie was unanimously voted to be the best length for modern conditions. Ties 8½ and 9 ft. in length have been used to a considerable extent of late by a number of trunk roads, with especially good results, and the 9-ft. length has been in use on the Houston & Texas Central Ry. for a number of years.

ssippi River, with estimates of cost and detailed statement of items, also drawings. The writer immediately took up the subject, visited New Orleans, made a general examination of the conditions and, as soon as convenient, returned with a competent assistant whom he set at work at once making detailed examinations, maps and plans. He personally examined various alternative routes for a belt railroad, possible locations for a union depot, had surveys made for a bridge over the Mississippi River and compiled all existing data in regard to locations of railroads and sidings upon a large map of the city. He also examined carefully into the status, legal and otherwise, of the various railroads which enter the city, particularly in regard to ordinances granted at various times by the city. He also spent considerable time in ascertaining on the ground what necessity there was, if any, and the extent of it, for a belt railroad and a union depot. The movement

He examined carefully into the arrangement of the terminal tracks of each road on the river front, particularly to ascertain the necessity, if any, for more extended terminals for any or all of them, and whether more room along the river for each of them would remove the obstacles which apparently existed to the prompt movement of freight cars and the transfer of cars particularly. He also became familiar with the peculiar method required at New Orleans for handling business from steamboats and steamships and the manner in which the freight to and from steamboats and vessels was transferred, handled and sent away by the railroads. The more important classes of business were carefully investigated to see what relief was necessary in the handling of the business—for instance, the grain, sugar and fruit. He spent, in all, many weeks in these detailed investigations on the ground. In the meantime he obtained, by the courtesy of the officials, of all of the

railroads, reliable information in regard to the number of cars transferred from one road to the other during the year 1888, which had just closed at the time he was making these investigations. The statements received from the railroads were in considerable detail, and in his report following the summaries only three were given. He also took pains to ascertain the amount and methods of business of belt railroads at Indianapolis, Peoria and in Chicago; from verbal conferences with officials of these roads and from written communications received from them, particularly in regard to their traffic and their general financial and operating plans, he obtained much valuable information bearing directly upon the subject in hand. He obtained, either by personal conference or by correspondence, information in regard to the methods of cities on the Eastern seaboard in reference to railroad terminals, particularly in New York, Boston and Baltimore. He also conferred with practical railroad experts familiar with belt-line plans, both financial and operating, in order to bring to this subject the most valuable information which could be found.

It is not pertinent to the present subject to give the detailed results of this very extended investigation which were contained in a report dated June 4, 1889, except to say that in that report the writer strongly recommended that the bridge be built above the city of New Orleans for the following reasons:

First—The four railroads from the West and North approach the city in nearly parallel lines separated by the river, making it convenient to connect them by a bridge above the city.

Second—The distance from the diverging point on the Southern Pacific and Texas & Pacific on the west side of the river, to a union passenger station located near or above Canal St., was materially shorter than the route over any location of a bridge below the city.

Third—No bridge could be built below the city sufficiently high for the masts of ocean sailing vessels.

Fourth—A drawbridge in the midst of or below such an amount of shipping and large ocean vessels as are found in the port of New Orleans should not be considered for a moment, particularly on account of the very strong and irregular currents and powerful eddies in the harbor; vessels and steamboats having at times become unmanageable and gone down the river entirely beyond control.

At the time of making the report it was the writer's opinion that the best location above the city was between 9-Mile Point and 12-Mile Point, not far above Southport, the up-river terminal of the Illinois Central lines. Subsequent surveys and investigation, however, located the bridge in the straight reach above 12-Mile Point, as shown on the accompanying map.

The writer had, in the course of his experience on the Mississippi, been brought into conflict with the Mississippi and Ohio river interests, at Memphis, Cairo, and on the upper Mississippi, in obtaining from Congress the charters for several bridges. He therefore, in advance of any Congressional action, obtained the views of the principal river navigation interests, hoping thus to avoid the usual conflict when the bill should be introduced into Congress.

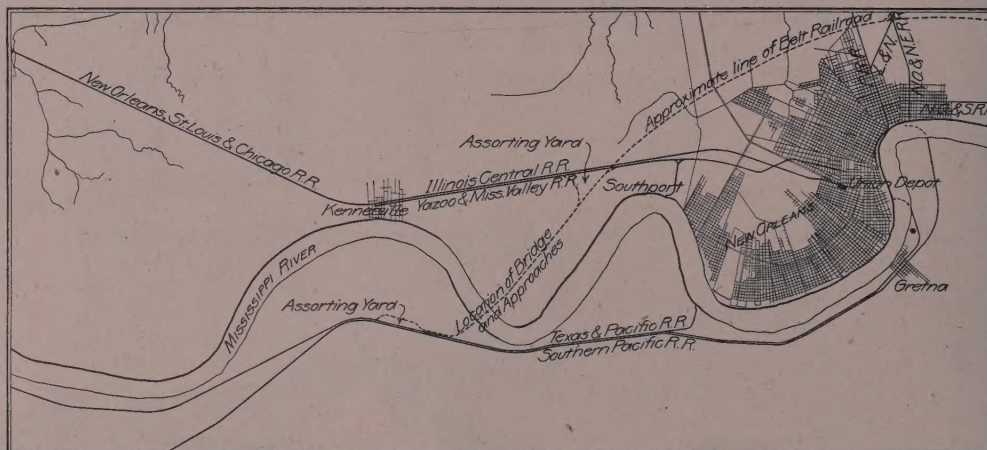
He submitted alternative plans to these river interests, a swing bridge, a pontoon bridge, and a high bridge. The parties thus consulted were the St. Louis & Mississippi Valley Transportation Co., Mr. Henry Haarstick, of St. Louis, president; the Anchor Line Steamboat Co., Captain Mason, president, and the coal boat interests at New Orleans, particularly Capt. D. B. Wood. These parties protested strongly against any kind of a swing bridge at New Orleans as being a serious obstacle to navigation, the principal objec-

tion being that a low bridge could not be easily seen at night or in a fog, and the delays in opening the draw with a steamboat or tow coming down under the influence of a strong current would certainly lead to disaster. The writer therefore struck out from the draft of the bill the alternative of draw and pontoon bridges, and the bill was presented to Congress for a high bridge with dimensions agreed upon with the representatives of river interests; spans not less than 800 ft. in the clear at low water and a height not less than 75 ft. The clearance height was submitted to the then Chief Constructor of the U. S. Navy, Commodore T. D. Wilson, who stated that one of the largest U. S. cruisers, the Chicago, just built, had 81 ft. from the water surface to the lower masthead. The bridge was therefore designed for a clear height of 82 ft. above the extreme high water under the central span and 75 ft. under the shore end of the two shore spans.

In 1891, and before obtaining the charter, there had developed a competitive project for a bridge proposed by the New Orleans Terminal Railway & Bridge Co., which was also proposing to build an elevated belt railroad and, in addition, was offering to take from the municipality the franchise for a belt railroad in the rear of the city, which the City Council was proposing to grant. The railroad interests were not desirous of this charter. This antagonized, to some extent, the railroads and the City Government in reference to

& Railway Co., which, by suggestion of Capt. A. C. Hutchinson, president of the Morgan line of steamships (Southern Pacific), he had organized and incorporated, the directors being leading citizens of New Orleans. The writer had been charged by his company with the task of obtaining the charter from Congress and making the surveys and plans for construction. With a corps of engineers he made a thorough survey and examination of all the physical conditions to determine where to locate the bridge to best subserve all interests and where the channel and banks were most stable, or, rather, least unstable. The entire historical record, all maps showing the many changes that had taken place during the last century or longer, all these were mapped and carefully studied. The result of this careful compilation and study of the situation was the selection of a location above 12-Mile Point, nearly five miles above the city limits. All other locations showed either present or past conditions that made a bridge location undesirable.

The river was carefully triangulated, sounded and bored at this point, and the current directions and velocity ascertained. The engineers assisting the writer were the late H. W. Parkhurst and Mr. J. L. Armstrong, now resident engineer of the union station at St. Louis, the latter having immediate charge of the work. Borings made to a depth of 209 ft. below low water at the proposed location showed much better material for



The Location of the Proposed Bridge Across the Mississippi Above New Orleans.

the bridge question, also the belt railroad project which the various railroads were undertaking to build. It was during this period and for this season that the City Government favored the building of a bridge below the city.

This bridge, as stated in the bill presented to Congress, was to have a central span of not less than 1,150 ft. and a clear height of 165 ft. The Board of U. S. Army Engineers detailed by the Secretary of War, after a careful study of the situation and a public discussion, decided against the building of any bridge below the city of New Orleans. It was then that the lower bridge people introduced a bill in Congress for the building of a bridge above the city, with a height of 120 ft. above extreme high water at the central span, thus proposing to occupy the very location which the Southern Bridge & Railway Co. had been attempting for a year and a half to obtain. This competition resulted in an antagonism in Congress which prevented the obtaining of the charter for two or three years. The Phenix Bridge Co., which was associated with the lower bridge interests, finally united with our own, and the exaggerated dimensions proposed previously by the Terminal Company had a considerable influence in fixing requirements by Congress in the bridge charter which was finally obtained on Jan. 26, 1893, after four years of constant effort.

During this period the writer had been president and chief engineer of the Southern Bridge

a foundation than had been expected. The river is 100 ft. deep, and below this depth the material composing the river bed is a clean gray sand, growing coarser as the depth increases, being quite coarse and somewhat sharp at 209 ft. As it was proposed to sink the two river piers to 170 ft. below low water, they would rest on coarse gray sand. With the bed of the river protected against erosion the foundation material was all that could be desired. The stability of the banks of the river at this straight reach, as proved from the old charts, gave assurance that no changes need be anticipated in the future in the course of the river, which could not be said of any point below this location.

The conditions of the act above mentioned were generally as follows: The bridge is to be within the upper limits of the city of New Orleans, if practicable, or within five miles above said city limits, at a location to be approved by the Secretary of War. The bridge is to be with three unbroken and continuous spans and with but two piers in the river. The length of the main channel span shall be at least 1,000 ft. measured in the clear at low water. The lower chord of the superstructure shall be horizontal, and the lowest point of the same not less than 85 ft. above extreme high water. This charter has been once extended by Congress. The plans to be referred to hereafter have been approved by the Secretary of War. The specifications in complete form for

tenders were drawn up, proposals were then called for and the tender of the Phoenix Bridge Co. declared to be the lowest. There is no doubt in the opinion of the writer that the bridge would have been constructed at the time, 1894, had the financial conditions of the country been satisfactory during that period. Mr. C. P. Huntington was quite desirous of its construction, but failed at the time to obtain the necessary co-operation of his associates and the other railroad companies interested.

Later, in 1901, after the death of Mr. Huntington, Mr. Charles M. Hays, while president of the Southern Pacific Co., was desirous of taking up the project again, but his retirement from the position prevented any further progress in the matter at that time. Capt. Hutchinson was always, to the time of his death in 1904, strongly in favor of the construction of the bridge, appreciating more than probably any one else, from his long and intimate experience at New Orleans, the great importance of the bridge to the large interests under his charge.

Another of the officers of the company, Col. Richardson, the treasurer of the company at New Orleans and the custodian of its plans and other documents, died not long ago, so that the strongest advocates of the bridge have passed away. Still the reasons for building this important structure grow stronger year by year, and the present method of transferring by ferryboat will, in the near future, prove too inefficient and expensive for the large commerce seeking to cross the river at New Orleans; so that the construction of this bridge is only a question of time.

The commercial and transportation features thoroughly and exhaustively studied out by the writer affect the whole Mississippi Valley, and the whole country as well, so importantly that they will not fail to interest the readers of The Engineering Record. Therefore there is given following a brief résumé of these features; there will also be given some alternative plans of the bridge in the way of an immense double drawbridge and a bascule bridge, the former proposed and worked out by the Phoenix Bridge Co., and the latter by Dr. A. L. Waddell and associates.

The general and special features, much of which were obtained by assistance of Mr. Norman J. Walker, the well-known statistician of the New Orleans "Times Democrat," were as follows in 1894; since that time there is evidence of a continual increase of the ocean and railroad commerce, for in January, 1897, in the statement made by the writer before the Rivers and Harbor Committee of the House of Representatives, United States Congress, he was able to state that the total commerce of New Orleans—ocean, railroad and river—had increased from 5,427,827 tons in 1876 to 10,397,493 tons in 1895, nearly 100 per cent. increase.

In January, 1894, the writer, as president, made a detailed report to the board of directors of the Southern Bridge & Railway Co. upon the subject of a bridge over the Mississippi River, in which he gave the data in regard to the commerce in general and the traffic which might be expected over the bridge in 1899, the date when it was to have been completed and open for traffic; also a description and estimate of the cost of construction and a description of the method of operating.

Summarizing and analyzing we find the following, premising these data with the remark that the South Pass jetties which have had such a great influence upon the commerce of New Orleans and upon the building up of the great Mississippi Valley Route were begun in 1875 and finished in 1879, their commercial effect dating from 1880. The tables of commerce therefore begin in 1876 and extend to 1892 at the close of the commercial investigation. The registered tonnage of entrances from the sea in 1876 was 1,908,

114; in 1892, 3,333,658. The development and changes in methods during this period are seen from the following: In 1876 the total number of steam vessels was 376, and of sailing vessels 918, and in 1892 the total number of steam vessels was 1,216, and of sailing vessels 142. The development is further seen by a comparison of various sizes of vessels by which it will be noted how rapidly the steam vessels were increasing in size and the sailing vessels decreasing in number.

TONNAGE OF VESSELS ENTERING THE PORT OF NEW ORLEANS, IN 1876 AND 1892, BY CLASSES, SHOWING NUMBER IN EACH CLASS.

Class.	Year.	1876.	1892.	1876.	1892.
Under 100 tons.				72	14
100 to 200 tons.				57	15
200 to 300 tons.		6	22	62	13
300 to 500 tons.		16	156	207	22
500 to 700 tons.		34	206	254	34
700 to 1,000 tons.		68	91	98	25
1,000 to 1,200 tons.		56	105	87	5
1,200 to 1,500 tons.		102	192	48	11
1,500 to 1,800 tons.		38	144	32	1
1,800 to 2,000 tons.		22	79	1	1
2,000 to 2,500 tons.		34	109		1
2,500 to 3,000 tons.			83		
Over 3,000 tons.			29		

The increase in the size of vessels would be still more marked if the large number of small vessels from 300 to 700 tons required by the tropical fruit trade had not been included in the table. These greatly increased in number during this period. The average registered tonnage of vessels during 1876 was 734 tons; in 1892, 1,224 tons. The value of ocean commerce increased between 1876 and 1892 from 137 million dollars to 233 million dollars, an increase of 70 per cent. The maximum draft of vessels increased from 17½ to 26 ft.

It is to be regretted that in spite of the immense sum of money spent in the improvement of the Mississippi River by the United States Government during the period in question, the river commerce decreased from about five million registered tons annually to three million tons, and from 3,300,000 freight tons to 1,900,000, and from \$174,000,000 in value to \$73,000,000. The above figures do not include rafts, oyster boats and luggers.

The anomaly is here presented of a great decrease of river traffic, while the sea traffic increases over 70 per cent. Two principal causes wrought this remarkable change, the opening of the mouth of the Mississippi River to the world and the great development of railroad traffic which this improvement brought about. In 1876 there were only three railroads entering New Orleans, the Illinois Central, Louisiana & Texas (Southern Pacific), and the New Orleans & Mobile (Louisville & Nashville). There was no great increase in railroad traffic until about 1880, a year after the maximum channel had been obtained by Capt. Eads at the mouth of the Mississippi River. The freight forwarded and received at New Orleans by rail in 1880 was only 878,494 tons, valued at \$99,741,708; in 1892 it was 3,980,996 tons, valued at \$245,492,900, an increase of 350 per cent. in weight and 150 per cent. in value, the latter fact showing how rapidly the railroads were increasing their tonnage in heavy and cheap freight, previously carried by the steamboats.

The accompanying table of total commerce is of great interest.

TOTAL COMMERCE OF NEW ORLEANS BY OCEAN, RIVER, RAILROADS AND CANALS FROM 1876 TO 1892, INCLUSIVE.

Year.	Freight.	Value.
1876	5,427,827 tons	\$371,464,128
1886	6,326,786 tons	\$456,062,948
1892	8,416,151 tons	\$553,167,305

Of the grand total of 6,326,786 tons of freight received and forwarded in 1886 the railroads carried 1,940,063 tons. The river (including steamboats, barges, flat boats, and rafts) and the canal to Lake Ponchartrain carried 2,881,593 tons.

Of the grand total of 8,416,151 tons of freight received and forwarded in 1892 the railroads carried 3,980,996 tons, and the river and canal 2,205,

923 tons. The railroads have more than doubled their tonnage in the last six years, but the river business has decreased over 23 per cent. in the same period.

The increase in railroad traffic is further shown by the fact that in 1880 the loaded cars moved at New Orleans were 131,959, the empties 28,373. In 1892-'93 the loaded cars moved were 422,297, and the empties 95,258; a total in the latter year of 517,555, and the former year 160,332—an increase of 222 per cent.

The transfer business over the Mississippi River increased in about the same ratio. With the regular annual ratio of increase of passengers the estimate in 1896 was 255,000.

Following are the data of freight traffic:

EAST-BOUND CARS.
1888-'89—54,012 loaded, 10,568 empty; total 64,580.
1892-'93—83,026 loaded, 17,965 empty; total 100,991.

WEST-BOUND CARS.
1888-'89—48,460 loaded, 16,265 empty; total 64,725.
1892-'93—69,572 loaded, 32,419 empty; total 101,991.
Total for 1892-'93 both ways, 207,982.

The estimated number of loaded cars in 1896 both ways was 190,191. It may safely be estimated that when the obstructive conditions by ferryboats are changed for a bridge, reducing expenses and difficulty, the increase will be very rapid. There is no doubt that well on to 300,000 loaded and empty cars might have been expected in 1896, and there is no reason why we might not expect at least 500,000 in 1906, had the bridge been finished in 1899 as expected.

It is unnecessary to go into the detail methods of handling the car traffic at New Orleans, to show how much more advantageous it would be to handle the cars via the bridge and belt line in the rear of the city, instead of receiving and dispatching them on the congested areas and over the tracks along the river front.

It was estimated that between the Illinois Central road and those on the opposite side of the river there were in 1894 over 150 loaded cars of freight interchanged daily. With a bridge built at the location proposed the distance saved would be 18½ miles over a crossing in front of the city, which conveys, however, only a faint idea of saving in time and cost.

To the failure to build the bridge at that time is to be attributed the fact that a car transfer boat was put on not long afterwards, and there are reports of a very large one now being proposed for the purpose. The location of this ferry crossing is a short distance below that of the proposed bridge. The vice-president of the Southern Bridge & Railway Co., Mr. Edward H. Farrar, of New Orleans, had control of a rear belt project with a terminal on the river at Chalmette, below the city. Believing that the bridge project would materialize, he located the tangent of his belt above the city so as to meet the tangent of the bridge approach. This belt road never has crossed the tracks of the Illinois Central lines near the river above the city, but it can at any time be extended to the bridge approach when that shall be built. This belt has connections in the rear of New Orleans with all the railroads.

(To be Continued.)

BIDDING BY THE CITY ENGINEER on all public works in Toronto, Ont., has effected a considerable saving for the city in 1905, for his tender was lowest on 130 contracts, 103 sidewalks and 27 pavements. In addition to these, 18 works were done by order of the Council without the formality of calling for bids, and four were taken from dilatory contractors. Of the whole number 121 were done by day labor under the supervision of the city engineer and the remaining 31 were done by contractors at the engineer's contract prices. The total amount saved for the city in 1905 is given in the annual report of the city engineer as \$10,687.13.

The Water Filter of the Jacob Tome Institute

The water supply for the Jacob Tome Institute, Port Deposit, Md., is derived from an impounding reservoir of 10,000,000 gal. capacity formed by an earth dam. Its entire area was stripped and excavated to a minimum depth of 7 ft. and a channel 600 ft. long was built on one side for the full length to provide for the discharge of floods without allowing the storm water to enter the reservoir. The dam is curved about 30 deg. in plan with the convex side downstream. It has a top width of 20 ft. and flat slopes, that on the upstream face being paved with concrete 5 in. thick reinforced with No. 10 expanded metal of 3-in. mesh. The paving is made in separate sheets with lap joints about 30 ft. apart to allow for expansion and the upper edge has a curb 3 ft. deep, carried below frost line, to prevent it from slipping.

The main dry weather supply is derived from springs with an average daily yield of 40,000 gal., which are located in the woods 400 ft. from the reservoir. After three years' service, growths of algae imparted disagreeable odors and tastes to the water and to obviate them, a duplicate filter plant has been constructed. The springs have been disconnected from the reservoir and their flow is taken through terra-cotta pipes with cement joints to a reinforced concrete receiving tank 13 ft. wide, 25 ft. long and 10 ft. deep. The inlet pipes discharge over two aerating trays above the receiving tank and the water flows from them over the top of the tank and enters the upper end of a vertical pipe extending half way to the bottom of the tank, where it is connected to the horizontal delivery pipe from the reservoir. This pipe is continued across the full width of the tank and serves as a mixing chamber in which the spring water imparts oxygen to the reservoir water and the mixed water is discharged through perforations in the pipe.

The spring water normally carries about forty parts in one million of carbonic acid gas and the reservoir water during the greater part of the summer is practically devoid of dissolved oxygen. The aeration of the spring water removes all but ten parts in one million of the CO_2 and provides enough oxygen to impart a fair percentage to the reservoir water. From the receiving tank, the mixed spring and reservoir waters are discharged over a second aeration tray into a tank with a copper float regulating the outlet valve so as to maintain a constant head of water on the three primary filters which it supplies.

The character of the water necessitated very thorough aeration and careful filtration. Owing to the presence of numerous organisms in the water, and to the possibility of Anabaena growths which have been detected but which have not so far been troublesome, it was thought necessary to provide for double filtration with aeration between the two sets of filters.

The six filters are all of the same size, 14x21 ft., and are arranged as three primary and three final filters. The plant has a capacity of about 100,000 gal. a day when both sets are in use, or twice as much when each set is used as primary filters, according to conditions, since during many months in the year single filtration is ample.

In normal operation both sets of filters are used and the effluent from each primary filter passes over a brass weir 4 in. wide and falls on the aeration tray over the well which supplies the intake pipes for the final filters. The effluent from the final filter passes through submerged orifices in the regulating chambers and thence to the filtered-water covered reservoir from which a 10-in. supply main $1\frac{1}{2}$ miles long leads to the Institute.

The plant occupies a 50x75-ft. rectangular area symmetrically arranged with relation to both

transverse and longitudinal axes. The three primary filters are in a row across one end and the three final filters in a corresponding row across the other end. The space between them is occupied by the 13x25-ft. receiving tank on one side and by a tool room and operating room on the other side. Between the tank and these rooms, there is at one end of the enclosed space, a supply tank and three effluent chambers for the primary filters, and at the other end a supply tank and effluent chambers for the final filters. Reinforced concrete platforms extend across the full width of the building over the inner ends of each set of filters.

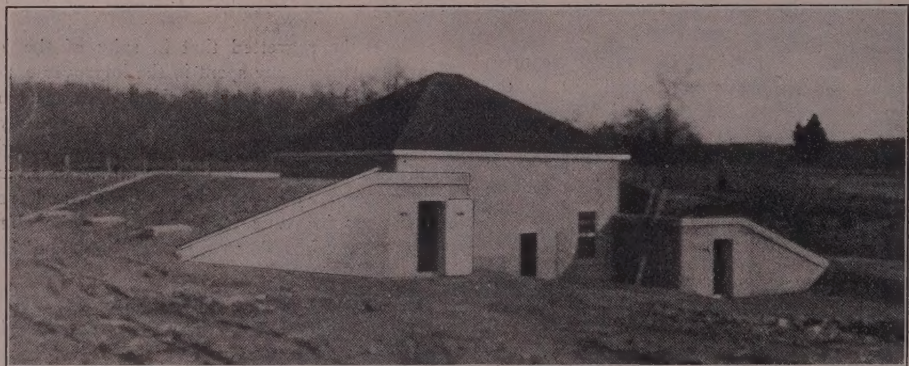
The filters were built in excavation, the walls and roof of each being made monolithic and constructed in advance of the floor in order to avoid the film of dirt likely to collect on top of the floor and prevent satisfactory bonding with the wall concrete. A 2x4-in. wooden strip was built into the forms about a foot above the bottom of the walls and provided a recess into which the floor concrete was afterwards bonded. The floors are monolithic with a horizontal lower surface and a convex upper surface, 12 in. thick in the center and 6 in. thick at the sides. The walls and roof are reinforced with Ransome bars and concrete was hand-mixed very wet in the proportion of 1:2:4 of Giant Portland cement, sand, dredged from the Delaware River, and run-of-crusher granite, passed through a $1\frac{1}{2}$ -in. ring.

On the center line of each of the six filters

then shoveled by hand into the adjacent tank; the outlet valve on the horizontal branch of the 6-in. pipe is closed, the valve on the vertical down-take is opened, and the water supply for the washing tank passing through the pipe cleanses it thoroughly from all scrapings left in it by previous service.

The 3-ft. 6x5-ft. 2-in. reinforced concrete washing tank $3\frac{1}{2}$ ft. deep is essentially a mechanical filter with a floor just above the bottom of the tank made with reinforced concrete ribs 7 in. deep and 6 in. wide. These have an approximately triangular cross section 1 in. wide at the top with a projection 2 in. deep and 2 in. wide at the bottom in which is located a row of vertical brass ferrules with openings $\frac{3}{8}$ in. in diameter through which the washing water passes up from the inlet pipe, through a layer of gravel between the floor ribs and through the stratum of scrapings, above which it rises 1 ft. and overflows across a waste weir at one side of the tank. Sand is shoveled out of the tank and wheeled back to the filter, about 2 yds. being washed in six minutes. The scrapings are allowed to accumulate until after the annual deep scraping, when they are all washed and returned to the filters by a gang of five men working one day.

The 2x8-ft. aerating trays 4 in. deep are made, like the ribs in the washing tank, with a 1:2 mixture of Portland cement and sand. The sides of the tray are 2 in. thick and are reinforced with two $\frac{3}{4}$ -in. rods. The bottom is $\frac{3}{4}$ in. thick



Filters and Operating House.

there is a reinforced concrete sluice just above the surface of the sand which has a clear span of 21 ft. and is supported at both ends on the walls of the filter. It is V-shaped in cross section with upper horizontal flanges extending the width to 2 ft. The channel in it is $4\frac{1}{2}$ in. wide at the top, $3\frac{1}{2}$ in. wide at the bottom and 8 in. deep. The concrete is 3 in. thick in the horizontal flanges, each of which is reinforced by a single $\frac{1}{4}$ -in. rod. Two 1-in. rods reinforce the 12-in. bottom part. The sluice is inclined 1:10 and receives the scrapings that are shoveled into it from the top of the sand and are carried through it and through 6-in. cast iron pipes on a 4 per cent. grade by a stream of water which transports it rapidly and continuously to the sand washing beds 20 ft. below the filters and 150 ft. distant from them.

The horizontal 6-in. pipe terminates with an outlet valve and a valved vertical branch, the latter passing under ground to supply the washing tank. The outlet valve on the horizontal pipe normally discharges the scrapings and water on a 17x27-ft. drainage platform depressed below the surface of the ground and paved with long strips of concrete 2 ft. wide 6 in. thick and 3 in. apart in the clear which are laid on a bed of gravel drained by collecting pipes which discharge to the sewer. The sand is distributed over the platform and water and quickly drains off through the spaces between the floor blocks. The moist sand is

and is reinforced by telegraph wires 2 in. apart in both directions with the ends wound around the lower rods in the sides. Each tray is pierced with 470 openings through the bottom to distribute the water in the filter tank. These openings, like those in the floor ribs of the washing tank, are made with vertical brass ferrules having apertures $\frac{3}{8}$ in. in diameter at the top. Pressed brass caps for awls were utilized for this purpose and each of them was set on a cork nailed to the bottom of the mold before the concrete was poured. After the concrete had set, the brass caps remained in position and provided regular orifices with enlarged openings below when the molds were removed and the corks withdrawn. Each tray is supported at the four corners and that they have abundant strength was demonstrated by an accident when one of them, two months old fell 9 ft. on the concrete floor without being broken or injured.

Each of the filters is provided with vertical sliding wall gauges indicating the loss of head due to clogging of the filter and the rate of discharge to the distribution mains. For the primary filters 10-in. vertical stand-pipes are connected with the under drains and the filter surface and in them are suspended copper floats balancing the gauge boards which have a free vertical movement with their adjacent edges in contact. The board connected to the filter surface float has marked on it only a zero point while that

connected to the underdrain has a graduated scale indicated loss of head. A third float is located in the water above the outlet weir and balances a board graduated to show by its displacement from the adjacent index, the number of gallons per day passing over the weir, thus enabling the operator to set the outlet valves to correspond with any required discharge.

The apparatus for the final filters is the same as above described for the gauge showing the loss

ent rate of consumption which varies from 50,000 to 100,000 gal. a day. The plant was put in operation December 23, 1905, and has been in continuous use ever since. The summer consumption is about 45,000 gal. daily, but when the plant was first started, the consumption indicated by the rate gauges was 93,000 gal. a day, which was reduced to 50,000 gal. a day after the discovery and rectification of a leak in the main to the Institute grounds.

water after leaving the primary filters containing so little organic matter that it is necessary to turn raw water on the final filters occasionally in order to maintain biological action in them.

The average results of the primary filters, according to the records for nine months are given in the accompanying table:

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	
Removal of turbidity	6	4.3	5	5	5.5	5.2	2.3	2.6	2.8	Raw water
	4.6	0.6	0.3	0	0	0	0	0	0	Filtered water.
Removal of color	29.4	29.4	25.9	24.6	30.0	26.0	14.5	11.1	13.0	Raw water
	25	22	18	13.5	12.2	10	8	5	5	Filtered water

Average parts in 1,000,000 of CO₂ in spring water, 45. The average amount of carbon dioxide in the spring water was 45 parts per million; in mixed spring and reservoir water after second aeration, 8.3 parts; in effluents from primary filters, 9 parts, and in effluents from final filters, 7 parts.

of head, but a different system is adopted to show the amount of discharge. The filter outlet communicates with an intermediate chamber from which the water passes through a 1.2-in. x 1.2-in. submerged outlet to the valve chamber supplying the service main. Copper floats are placed on the surface of the water in the filter, in the intermediate chamber, and in the valve chamber and to each of them is connected a vertical sliding gauge board arranged side by side on the wall in positions corresponding with those of the floats. That for the intermediate chamber being in the center with the filter float and the valve chamber float adjacent to it on opposite sides. The center board is marked only with a zero point on each vertical edge. The board for the valve chamber is graduated to indicate the loss of head and the board connected to the filter float is graduated to show the rate of discharge, thus affording a very simple and convenient index of operation and enabling the at-

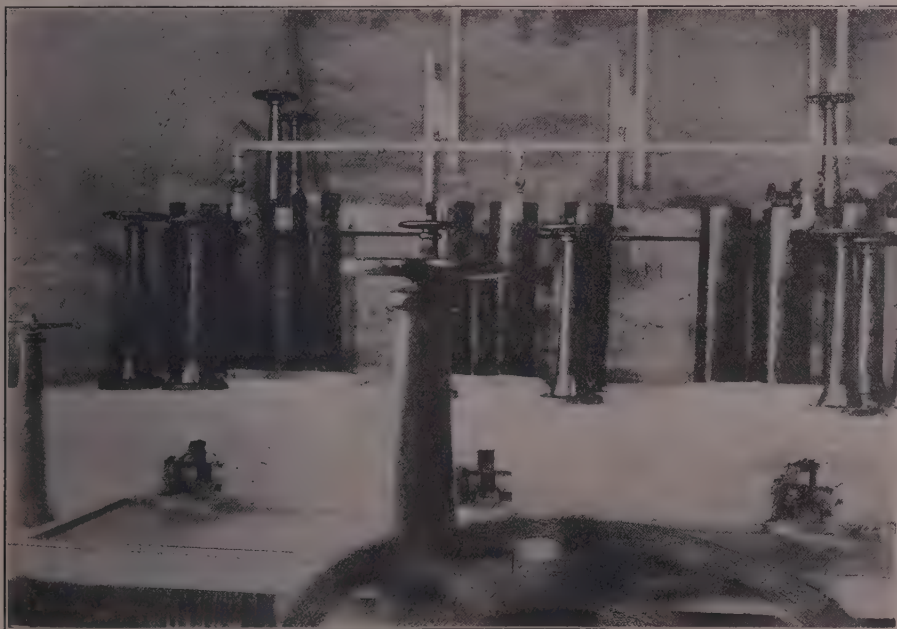
The primary filters have been scraped nine times within the past ten months, including the



Construction of Concrete Roof.

tained when the filters have been freshly scraped. This began in the middle of June and lasted two months. The records of the Washington filters, about 80 miles distant, showed the same phenomenon at the same time.

The plant above described cost about \$10,000, and was built entirely by day labor. Mr. James H. Fuertes, of New York, consulting engineer of the Jacob Tome Institute, designed the work and supervised its construction.



Gauges for Primary Filters.

tendant to regulate it accurately by the valves. This system is somewhat more sensitive than that of the primary filters because the submerged orifice affords a greater variation of head than does the weir and provides for a maximum flow of about 40,000 gal. a day from each filter. The light wooden gauge boards are painted white and have raised metal figures cemented to them, and painted black with india ink, as are the graduation marks. Perforated brass strips at the upper and lower ends of the boards engage tightly stretched No. 25 phosphor-bronze vertical wires on which the boards move without friction.

The normal rate of operation of the plant is about 3,000,000 gal. per acre per day at the pres-

annual deep scrape during October. The average length of run was 33 days, the longest run 95 days and the shortest run 11 days. The average rate of filtration was 2,900,000 gal. a day. The minimum rate 1,900,000 gal., the maximum 4,450,000 gal. per acre per day. The average quantity of water filtered per acre between scraping was 90,000,000 gal. with a minimum of 30,000,000 and a maximum of 215,500,000 gal. per acre. The average quantity of sand removed per 1,000,000 gal. filtered was about 2 cu. yd. The average amount of sand removed per acre of filter surface was about 170 yd. The ratio of the volume of wash water to the volume of sand washed was 5.1 to 1.

The final filters have never been scraped, the

SMOKE PREVENTION is now attracting the attention of the authorities of a number of cities of the first rank and the importance attached to the subject in such widely separated communities shows a healthy appreciation of the necessity of abating the soot and dirt which are such a nuisance. In Baltimore an ordinance has been adopted prohibiting the discharge of black or dark-gray smoke for more than six minutes in any hour, under penalty of a fine of \$25 for the first offense and \$10 a day for subsequent violations. The enforcement of the ordinance is in the hands of the health commissioner. In Buffalo, where a smoke ordinance has been in force some time, steps are now being taken to insure compliance with it. Mayor Adams of that city has been looking into the methods adopted in St. Louis and elsewhere, and it is expected that steps will be taken by him in a short time to abate the nuisance. The most interesting indication of the general feeling of dissatisfaction with a smoky atmosphere is the discussion by Councils in Pittsburgh of proposed ordinances to reduce the trouble. The Smoky City has tried before to belie its name by municipal ordinance, but the impracticability of the preventative means or the opposition to their introduction led to an abandonment of them. This experience has been so instructive that the discussion over the terms of the ordinance has been unusually interesting, bringing out strong objections of a practical nature to some proposed requirements which seem at first sight entirely reasonable.

The Valparaíso Earthquake.

The effect of the earthquake at Valparaíso on the night of Aug. 16 was most destructive, not only on account of the severity of the shocks, but also because of the character of most of the buildings. Most of the damage was due to the earthquake and not to fire, contrary to the experience at San Francisco. The water-works system is new, and although the shocks put it out of commission for a short time, service was resumed everywhere in two days, and all repairs were made in four days. The city was put under martial law and Capt. L. G. Carrens, of the Chilean navy, was placed in supreme command. Under his strong rule sanitary and police regulations were rigidly enforced and the recovery of the city from its plight began immediately. The extent of the disaster was greater than might be expected in a country exposed to serious shocks, for a long period of immunity from marked disturbance of this character had led to the extensive use of types of construction not adapted to withstand such destructive action. The following notes concerning the earthquake

not injured so much as those on filled land. This produced the rather strange result that old structures of only moderate strength remain intact while buildings of a better character are in ruins, which cannot be ascribed wholly to the fires that followed the earthquake.

The greatest desolation occurred in the district south of the bay known as Almendral and Bella Vista, where the shock was apparently most severe, and fires could not be controlled. From the waterfront back to Victoria St., the leading street of the city, the buildings were mostly of masonry and comparatively new, yet their destruction was practically complete, and the photographs show scenes of desolation as pitiable as anything presented in San Francisco. From Victoria St. to the south were the homes of most of the working people, and the desolation here produced great suffering.

At the southeastern part of the bay is the Baron district, where the damage was comparatively trifling, except toward the low land. The high territory, known as English Hill, where the foreign colony resided, suffered less than any other part of the town from the earthquake, but there

The first shock occurred about 7.50 p. m. and lasted about 1½ minutes, having an east and west motion. It was very severe, throwing down the ornamental cornices and the stucco work of many buildings and producing immediate confusion. Fortunately, the operating staff at the electric railway station recognized the nature of the disturbance and immediately shut off the current. The second shock came about ten minutes later and was stronger than the first. Its vertical motion was greater and it threw down buildings injured by the first tremor. Less violent shocks were felt afterward for a number of days, and their effect on the damaged buildings was a source of much danger.

Interstate Water Rights.

Interstate water rights are involved in an important decision recently made by the New Jersey Court of Errors and Appeals. Last year the legislature enacted a law prohibiting the diversion to other States of any of the potable waters of New Jersey. The Hudson County Water Co. made a



View in the Almendral District of Valparaíso Showing Destruction Caused by Earthquake and Fire.

and its results have been compiled from information furnished by Mr. Formidas Enrique, a civil engineer, with offices in the city.

The city is built around the bay of Valparaíso, partly on filled ground, where the effect of the shocks was far more serious than elsewhere. At the northwest is the suburb of Playa Ancha, where the large building of the Naval College is located on the waterfront. This was a structure of brick, stone and steel and was practically ruined, only the steel frame keeping it standing. In striking contrast with it is an older three-story masonry building adjoining it which photographs indicate to be without any sign of marked exterior damage. This structure was one of the few in the lower part of the suburb that escaped serious damage.

The next district of the city along the bay shore is the oldest part, known as the "Puerto." A large portion of it was on solid ground and formed the financial and commercial center of Valparaíso. The buildings on firm ground were

was some damage by fire the first night. A strict guard was maintained afterward and there was no further trouble of this nature. It might be said that many of the fires in the city were unquestionably of incendiary origin, but anybody caught in such crimes was immediately shot.

At Vina del Mar, a suburb about seven miles distant, the damage was considerable, but a large sugar refinery which employs over 500 hands suffered very little serious injury and was started up in all departments as soon as the debris of some of the outside walls was cleared away. At Santiago, the capital, some of the government buildings were damaged and a few hotels were rendered uninhabitable. Numerous houses were shaken, but their injury on the whole was not so great as to be beyond repair.

The railway between Valparaíso and Santiago did not suffer to any considerable extent. Numerous repair gangs were sent out as soon as the first shocks were over, and in a few days the train service was resumed.

contract with the city of New York to furnish the Borough of Richmond with a supply of water from sources controlled by the East Jersey Water Co. The attorney-general of New Jersey brought a suit to restrain the Hudson company from carrying out this contract, on the ground that it was a violation of the act mentioned. The company contended that the act was unconstitutional and it is this contention that the court of final jurisdiction has just overruled. The court points out that the common law recognizes no right in the riparian owner, as such, to divert water from streams in order to make merchandise of it, and the State has not, by statute, changed this rule. On the contrary, the legislative policy has been to preserve and administer the waters of the State for the benefit of its rapidly growing population. There is no provision of the federal constitution violated by the law of 1905 and consequently the Hudson company has no right to contract to deliver any potable water from the State of New Jersey to the city of New York.

James Dredge, C. M. G.

In the Current News Supplement of The Engineering Record of August 25 there was a brief announcement on the death of James Dredge, who for a number of years was editor of "Engineering," London. That brief note should be supplemented by a somewhat longer account of the life-work of one who paid many visits to this country and showed throughout his eventful career a most marked interest in and sympathy with America and American engineers.

James Dredge was born at Bath, England, on July 29, 1840, and was, therefore, at the time of his death in his sixty-seventh year. He was the son of James Dredge, of Bath, from whom he undoubtedly inherited much of his engineering ability. Mr. Dredge began his professional training at an early age by becoming apprenticed to his elder brother, the late William Dredge, who was at that time in practice as a civil engineer in London.

He entered the office of the late Mr. D. K. Clark in 1858 and remained in his service till the year 1861. It was during this period that Mr. Dredge had the good fortune to become acquainted with that great American genius, the late Zerah Colburn, who was, in companionship with Alexander Holley, revisiting England with a view to learning the current railroad practice of the country. It was also about this time that Mr. Clark was preparing his book "Recent Practice in Locomotive Engineering," a supplement to his well-known work on "Railway Machinery." These facts are interesting because Mr. Dredge was engaged in the preparation of certain illustrations for Mr. Clark's book and the fact that Mr. Colburn consented to contribute some chapters on American locomotives to Mr. Clark's book was the means of bringing the subject of this memoir into intimate contact with one who was destined to have an important influence on his subsequent career. In 1862 Mr. Dredge entered the office of Mr. John Fowler, afterwards Sir John Fowler, and there he was engaged upon some of the plans for the Metropolitan District Ry.

Mr. Dredge's connection with "Engineering" began with the conception of that great technical journal in 1866 and came about in the following way: Mr. Colburn had been editor of "The Engineer" from 1855 to 1860, when he resigned his position. In 1861, however, he resumed it again and continued as editor to that paper until 1864, when he determined to establish a technical journal of his own, which he did two years later in the form of "Engineering." Mr. W. H. Maw, the present editor of "Engineering," was Mr. Colburn's sub-editor and Mr. Dredge was made responsible for work connected with illustrations. This arrangement lasted for three years, and Mr. Dredge, in addition to his other duties, occasionally contributed to the editorial columns.

Zerah Colburn died in 1870, and it was then that Mr. Dredge became co-editor with Mr. Maw. From this date until May, 1903, when he was stricken with an attack of paralysis—a period of 33 years—Mr. Dredge took a most active part in the conduct of "Engineering," and his determination to make that paper a power in the engineering world, using that expression in the broadest sense, must be recognized as one of the greatest factors in placing that journal in the foremost rank of technical publications.

In addition to his editorial work, Mr. Dredge took a life-long interest in international exhibitions. Perhaps there is no better way of showing how thoroughly he pursued this work than by enumerating the various offices he held in connection with international exhibitions. The following paragraph is from "Engineering" of Aug. 24th:

"Contemporaneously with his editorial work, Mr. Dredge for over thirty years took an exceedingly keen interest in international exhibitions. In addition to his work for 'Engineering' in connection with the Vienna Exhibition of 1873, the Centennial Exhibition at Philadelphia of 1876 and the Paris Exhibitions of 1878 and 1889, he was a member of the Royal British Commission for the Chicago Exhibition of 1894, was Commissioner General for Great Britain for the Brussels Exhibition of 1897, and was one of the Vice-Presidents of the British Commission for the Milan Exhibition of this year. For his work in connection with the Paris Exhibition of 1889 he was appointed an officer of the Legion of Honor and for his services with respect to the Brussels Exhibition he was made a companion of the Order of St. Michael and St. George."

Mr. Dredge was an author of considerable note and a number of his works have been published in book form. "Modern Examples of Road and Railway Bridges" (1872), "The Vienna Universal Exhibition" (1873) and "Electric Illumination" (two volumes, 1882) were his works written in collaboration with other writers. His book entitled "Pennsylvania Railway," was published



James Dredge.

in 1879 and his work "Modern French Artillery," in 1892. The latter added considerable repute to his name, and, at the time of its publication, was without doubt the finest and most complete work of its kind. He published the "World's Columbian Exposition Report" in 1894 and the "Thames Bridges" in 1897; his book "The Works of Messrs. Schneider & Company," appeared in 1900, and in 1904 he edited an autobiography of Sir Henry Bessemer.

At the time of his death he was preparing a book which, had it been published, would have been of special interest to American readers, as it was an account of the lives of the great American engineers he had known. There are many eminent American engineers living today who can testify to his great regard for them, their country and their work, and also with what pleasure and hospitality he received America's leading men, but these memories can hardly leave so indelible a proof of his appreciation of their works as this last unpublished manuscript would have done had he been spared to bring it to a conclusion. The spirit of the book can best be told by citing the motto he had chosen for this work. It was taken from Samuel Taylor Coleridge's

"Table Talk": "I for one do not call the sod under my feet, my country; but language, religion, laws, governments and blood, identity in these make men of one country."

As already mentioned, Mr. Dredge paid several visits to the United States. On the first occasion, in 1868, he wrote accounts of a number of American works for "Engineering," and during his second visit in 1876 his work was in connection with the Centennial Exhibition. In 1890 the Iron and Steel Institute of Great Britain, at the invitation of the American Institute, held its meeting in America, and advantage was taken of this occasion to ask Mr. Dredge to read an inaugural address at the unveiling of a bronze bust which had been erected in Washington Square to the memory of Alexander Holley. Mr. Dredge and Mr. Holley had been life-long friends, and the address the former read on this occasion showed most eloquently how he appreciated his friend and admired his work.

Mr. Dredge was a member of both the Institute of Mechanical Engineers and the Institution of Civil Engineers. In 1886 he was elected an honorary member of the American Society of Mechanical Engineers. He also served for some time on the Council of the Society of Arts.

Mr. Dredge never fully recovered from his stroke of paralysis in 1903 and although he spent considerable time in editing "Traction and Transmission," a publication of which he was the founder and in which he took keen interest and great pride, he spent most of his time out of town during the last three years of his life, either at his home in Titchfield, Hampshire, or in the South of Europe. He returned from San Remo only a few weeks before his death.

It would be unfitting to close this brief memoir without special mention of the very keen interest Mr. Dredge took in young engineers and his never failing readiness to help willing workers with the advice he was so well qualified to give. His attitude in this direction can best be told in his own words: "If we, the engineers of this generation, were each of us to help one rising engineer of the next—not help with money, but with advice, counsel and encouragement, help them to work and carve out their own career—our profession would be benefited and good solid work done in the world."

TESTS OF A CURTIS TURBINE were recently conducted at Waterloo, Iowa, by the Citizens Gas & Electric Co. The turbine is of the latest four-stage type and operates a 500-kw. alternator. Steam is supplied at 150 lb. pressure without superheat, and means is employed for removing moisture. The step-bearing is supplied with water under 300 lb. pressure. No accumulator is used. The condensing apparatus is of the surface type. The air pump is of the Edwards type and is driven by a 12-h.-p. motor. Water is supplied to the condenser by a centrifugal pump driven by a 30-h.-p. motor. All of the instruments and weighing scales were carefully calibrated before the test. The steam consumption was determined by weighing the condensed water, and the current consumption was determined for each auxiliary separately. The results of the tests were as follows: First test, average load, 253 kw., steam pressure 150 lb., steam consumption for generator 21.67 lb., and for auxiliaries 4.94 lb., total coal consumption 4.09 lb. Second test, average load 366 kw., steam pressure 149 lb., steam consumption for generator 21.82 lb., and for auxiliaries 3.37 lb., total coal consumption 3.87 lb. Third test, average load 518 kw., steam pressure 147 lb., steam consumption for generator 19.61 lb., and for auxiliaries 2.47 lb., total coal consumption 3.27 lb. Fourth test, average load 750 kw., steam pressure 144 lb., steam consumption for generator 19.52 lb., and for auxiliaries 1.71 lb., total coal consumption 3.34 lb.

Mechanical Equipment of the Carnegie Library Extension, Pittsburg, Pa.—VI.

Electrical Equipment.—The electrical equipment is of a magnitude seldom equalled in public buildings of any character. Artificial lighting has been provided profusely for both general illumination and artistic effects, a total of nearly 30,000 incandescent lamps having been installed. For the operation of the ventilating fans, printing department machinery and other power apparatus, over 500 h.-p. in motors has been installed. There is also a large installation of intercommunicating telephones, a fire-alarm system, watchman's time detector apparatus, electric time clocks and call bells, for the operation of which a low-voltage distribution system with storage battery auxiliary has been installed.

The generating apparatus and its auxiliaries were described last week. The distribution sys-

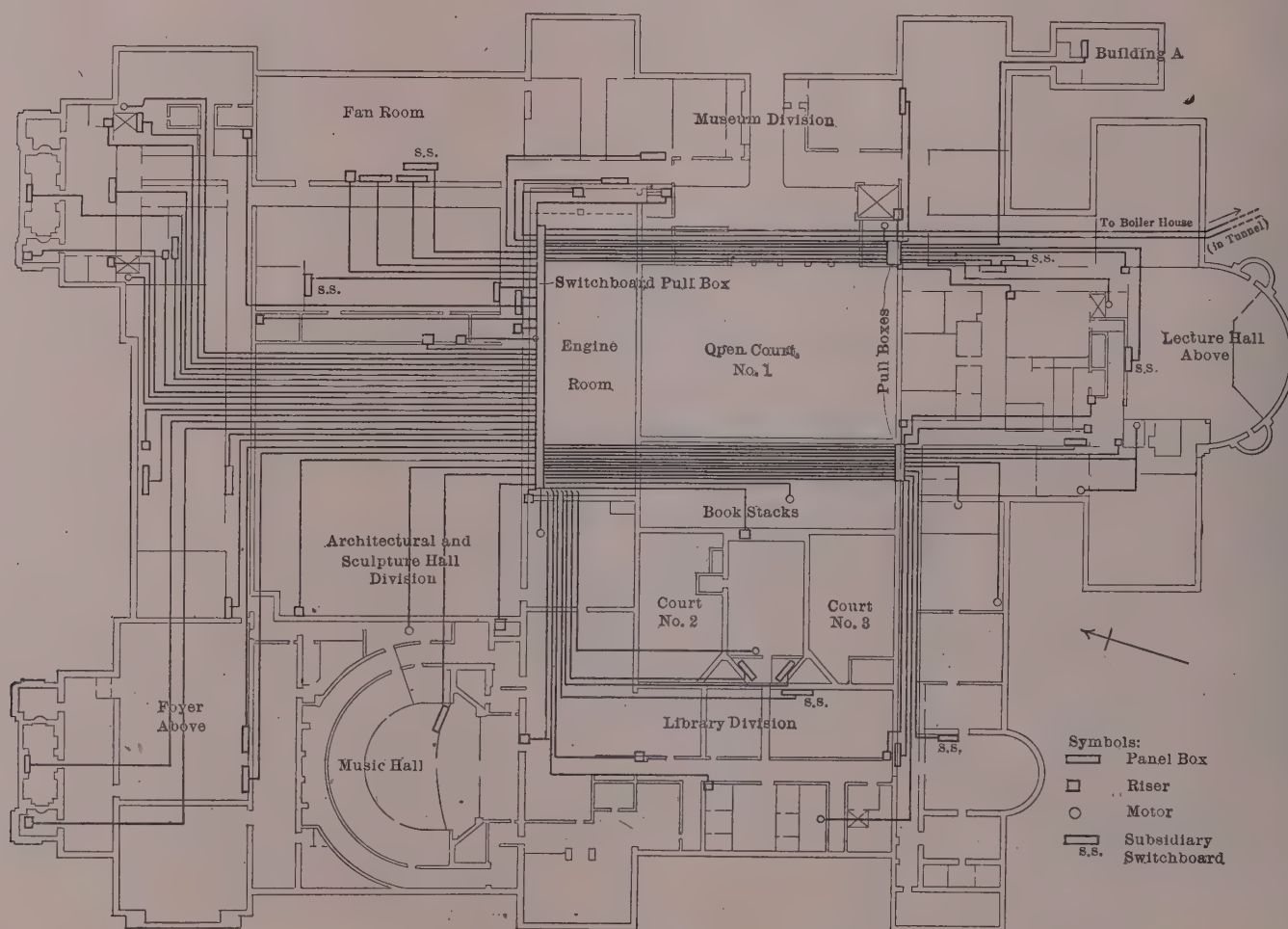
tem has 59 cables supplying local lighting circuits and 27 motor feeders. For the convenience of connections of the feeders to the switchboard, there is installed over the space at the rear of the board a pull-box of sheet steel construction which extends the entire length of the board. Its top is covered with removable marble slabs. Practically all feeders terminate in this box where connection is made to the respective supply switches by buses extending down through bushed openings in the bottom of the box. This arrangement does away with all heavy work of pulling cables in the space at the rear of the board, the feeders being brought only to the pull-box and thence connected to the circuit-breaker terminals by short, bare copper buses.

The wiring for lighting is in three groups; regular circuits, hall circuits for lighting the architectural and sculpture halls, foyer, art galleries and museums, and night circuits to a few lights in the corridors and certain rooms. All circuits are operated on the convertible two-wire

sible to the feeder and distribution connections.

The wiring is run in rigid enameled iron conduit of the usual type and the panel boxes are of heavy steel with slate panels. A number of feeder pull-boxes have been placed at convenient points in the system to make it easy to pull cables into place and also to permit easily replacing present feeders. The majority of the feeders were 200 to 400 ft. long, some having lengths of 600 ft., and most of them exceed 200,000 circ. mils. in size. The two outer legs of the three-wire feeders are connected together for two-wire operation, and all branch circuits are installed on the loop system.

Extensive use has been made of studded lighting in the building and large ceiling chandeliers, reflector lights and wall brackets are used to secure the required illumination. Special showcase lights are installed in the many large exhibition cases, to bring out satisfactorily the details of the specimens. There are 10,064 lamps on the



Arrangement of Distributing Feeders in the Basement of the Carnegie Library Extension.

tem has 59 cables supplying local lighting circuits and 27 motor feeders. For the convenience of connections of the feeders to the switchboard, there is installed over the space at the rear of the board a pull-box of sheet steel construction which extends the entire length of the board. Its top is covered with removable marble slabs. Practically all feeders terminate in this box where connection is made to the respective supply switches by buses extending down through bushed openings in the bottom of the box. This arrangement does away with all heavy work of pulling cables in the space at the rear of the board, the feeders being brought only to the pull-box and thence connected to the circuit-breaker terminals by short, bare copper buses.

The two novel features of the electrical installation are the use of double-coil circuit-breakers to the exclusion of knife switches on the switchboard, mentioned last week, and the

system through 59 panel boards and eight sub-panels, made up in varying numbers of sections as required, each board having a number of bus-bar and tap-switch sections corresponding to the arrangement of lighting which it supplies. Panel 17, for instance, in a basement corridor, has one section of bus-bars and tap-switches for regular lights and nine sections supplying a corresponding number of sets of tap-switches for studded lights in some of the large rooms of the museum above, which are operated through nine automatic switches on the panel board. A hall and night section are also provided on this board. Panel 3, located in a basement corridor, includes 14 tap-switches, while panel 38, in a third-floor corridor, has four divisions and 360 tap-switches. The panel boards, especially those containing automatic switches, have been located with special reference to accessibility from a convenient corridor and at the same time as close as pos-

sible to the feeder and distribution connections. The wiring is run in rigid enameled iron conduit of the usual type and the panel boxes are of heavy steel with slate panels. A number of feeder pull-boxes have been placed at convenient points in the system to make it easy to pull cables into place and also to permit easily replacing present feeders. The majority of the feeders were 200 to 400 ft. long, some having lengths of 600 ft., and most of them exceed 200,000 circ. mils. in size. The two outer legs of the three-wire feeders are connected together for two-wire operation, and all branch circuits are installed on the loop system.

Extensive use has been made of studded lighting in the building and large ceiling chandeliers, reflector lights and wall brackets are used to secure the required illumination. Special showcase lights are installed in the many large exhibition cases, to bring out satisfactorily the details of the specimens. There are 10,064 lamps on the first floor, 9,392 on the second floor, 6,925 on the third floor, 2,540 in the basement, 141 in the pipe cellar and tunnel, and 157 in the boiler house, the total being 29,219.

An interesting detail of the lighting system is the provision for lighting the eleven-story, 40x 120-ft. book-stack wing of the library. Each stack level has 19 circuits. Eight are for general interior lighting and are controlled from a centrally located panel board; one supplies two four-light chandeliers, and each of the remainder a row of 8 to 13 lamps in aisles between the stacks. Each cross aisle is lighted by three drop lamps controlled by switches at the center-aisle ends of the three is wired an extension cord and portable lamp for searching between the stacks. The portable lamp, normally hung from a bracket on the stack, is fed through a tap back of the switch controlling the three drop lights, and is thus con-

trolled independently. At every third stack there is a small table at the window end, which is lighted by a single-light drop chandelier fed from the corridor circuit. Each floor has 242 lights wired, 74 on the aisle circuits controlled from the central panel board and 168 drop and portable lamps. The book stack wing has over 2,600 lamps in all.

The power circuits are supplied either directly from the main switchboard or, as in most instances, from one of the eleven subsidiary switchboards which are connected by separate feeders with the main board. Subsidiary board 1 supplies a group of six motors running fresh air fans in the northeast corner of the basement, and boards 8, 9, 10 and 11 furnish current to the remaining groups of fan motors in the basement. The attic ventilating fan motors are operated from subsidiary boards 3, 4, 6 and 7. Board 2 supplies 11 motors and electrical apparatus in the printing and bookbinding department, where the equipment includes motors driving three linotype machines, two platen presses, a paper cutter, a saw, a folding board, a cylinder press, and a stitcher, and electric heating in two blue heaters, drying racks, and platen presses. Subsidiary board 5 is in the superintendent's office, several hundred feet from the engine room, and its func-

tion is to keep the superintendent informed as to the operation of the engine-room machinery. The board is of statuary marble, 2 in. thick, the bottom resting on an 8-in. marble base. It consists of three panels averaging 35 in. by 6 ft. 8 in. high, and a marble cornice and marble top slabs connect the top of the board to the wall. Five column-type recording ammeters made by the Whitney Electrical Instrument Co. are used, each giving a reading up to 3,000 amps. and reading on its respective dynamo. A five-set time-service indicating equipment, also made by the Whitney Co., records the hours of operation of each engine. A recording voltmeter of the Chauvin & Arnould type makes permanent records of the condition of the voltage. On this board are also placed steam and vacuum gauges from the steam header and heating systems.

The electric time-clock system consists of a master clock and thirty-two secondary clocks in different parts of the building. The master clock has an electrically-operated movement of the self-winding type, and is fitted with a mercurial compensating pendulum which will regulate within a variation of ten seconds per month. The body of the master clock is fitted with a three-circuit switchboard by which the thirty-odd secondaries are operated on three separate circuits. This switchboard provides a pilot or indicator for each circuit of clocks and a battery gauge so wired that it may be plugged into the circuit of any one of the three circuits and show the normal battery current. It contains also switches and an electric setting device by which any one of the circuits may be manipulated from the master clock.

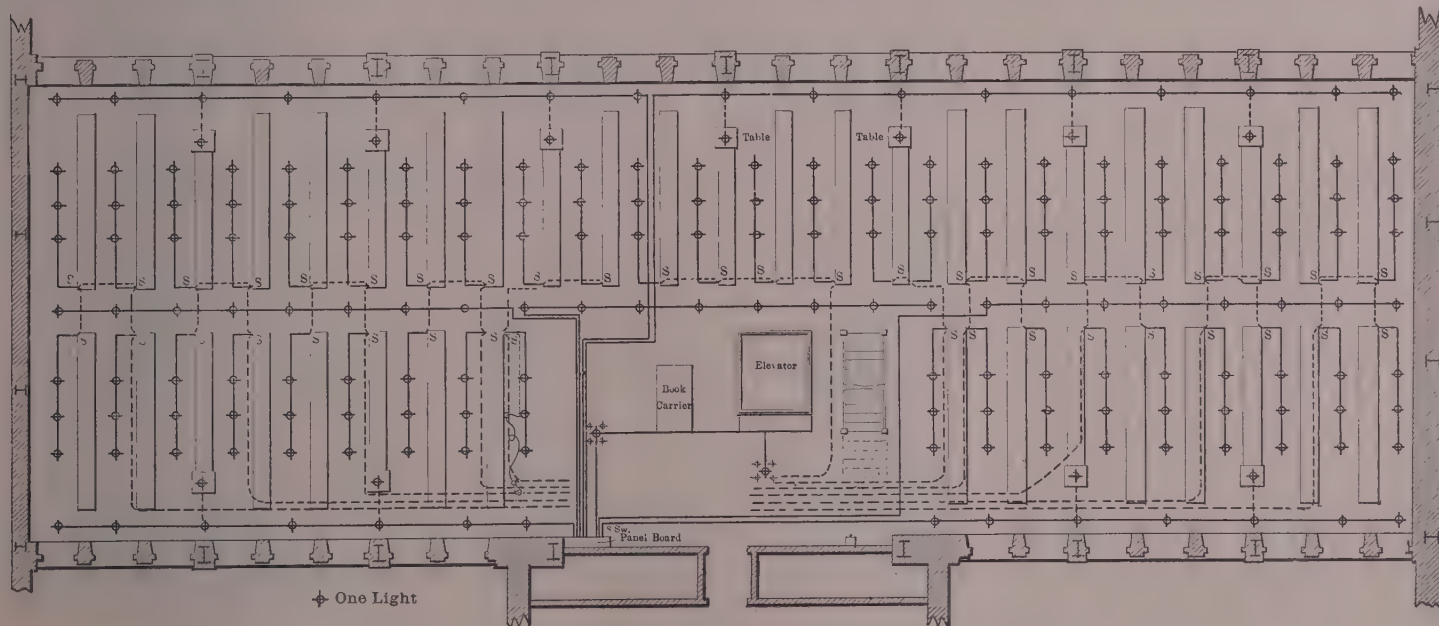
All secondary clocks are fitted with a double-ratchet secondary movement of the locking type, having magnets wound to 10 ohms and are connected in series. Each circuit draws 0.1 ampere, and in this manner the entire system is operated from one common battery of about 18 volts, the maximum draft being 0.3 to 0.4 ampere. A re-

The Burning of Washer Slate and Coke Braize.

By C. G. Atwater, M. Am. Soc. M. E.

While operating a boiler plant at Sydney, Cape Breton, the writer had an experience in the burning of washer slate and coke braize that may be of interest to those concerned in the use of such low grade fuel. The plant in question was of 1,500 rated horse-power and consisted of six horizontal water-tube boilers, arranged in three batteries of two each, in a single row. A steel-plate draft flue extended overhead along the back of the boiler settings, leading to a 7x125-ft. brick stack at one end. The boilers were originally provided with an extension furnace or "Dutch oven," containing ordinary grate bars, the surface being 8 ft. wide and 7 ft. deep. While this type of furnace may have advantages for some fuels, it is not adapted to a low-grade fuel with a short flame, such as was under trial.

The coal used was from the local mines, and while it was low in ash and high in calorific value, it carried from two to three per cent. of sulphur, coked strongly on the grate bars, and slagged badly, making it difficult to fire economically on ordinary grates. This coal was used in the by-



Arrangement of Lighting Wiring on a Typical Book Stack Floor.

tion is to keep the superintendent informed as to the operation of the engine-room machinery. The board is of statuary marble, 2 in. thick, the bottom resting on an 8-in. marble base. It consists of three panels averaging 35 in. by 6 ft. 8 in. high, and a marble cornice and marble top slabs connect the top of the board to the wall. Five column-type recording ammeters made by the Whitney Electrical Instrument Co. are used, each giving a reading up to 3,000 amps. and reading on its respective dynamo. A five-set time-service indicating equipment, also made by the Whitney Co., records the hours of operation of each engine. A recording voltmeter of the Chauvin & Arnould type makes permanent records of the condition of the voltage. On this board are also placed steam and vacuum gauges from the steam header and heating systems.

The secondary electrical systems installed in the building include the call-bells, fire-alarms, watchmen's time-detector, inter-communicating telephones and time-clock equipments. The current for their operation is supplied at 20 volts from a motor-generator and storage battery located in the engine room. The motor-generator is driven from the power busses and charges the storage battery, which in turn supplies current

lay operating all three circuits draws 0.15 amperes at 2 volts, and the self-winding mechanism of the master clock draws the same amount once per minute. The clock system was furnished by the Standard Electric Time Company, of Waterbury, Conn.

The entire electrical equipment was designed by the consulting electrical engineers, Messrs. Clark & MacMullen, New York and Pittsburgh, their Pittsburgh representative being Mr. L. L. Emerson. The Western Electric Co., of New York, were the contractors for the complete wiring installation, including also the main switchboard and panel boards.

IN TESTS OF ALCOHOL AS FUEL for internal combustion engines, a Western gas engine manufacturer has found that while a much smoother running engine is the result, owing to the higher compression possible and the slower combustion rate with alcohol, the extravagant claims for low costs of operation are not to be realized in practice. The amount of fuel consumed, under a wide range of operating conditions, was found to be practically the same per horse-power-hour as with gasoline for fuel, averaging for small units, about 1 gal. per horse-power for 10 hours.

product coke ovens to which the boiler plant was tributary, and in washing it for reduction of the sulphur a large amount of refuse slate had been piled up. It was proposed to ascertain whether this slate, either alone, or in combination with the refuse coke braize constantly produced from handling the coke, could be used successfully for steam making. As the slate was at hand for merely the cost of loading, and the braize was loaded on cars in any event, to get it out of the way, it will be evident that the prospect of saving money was good, if the material would make steam.

In order that the facts should be arrived at in a direct and conclusive manner, alterations were made in the boiler furnaces, and a series of tests carried out, the object, in general, being to find out the best form of furnace and grate for burning the slate and braize, and, incidentally, what might be expected from the coal itself.

One boiler was fitted with the grates, bridge wall and steam jet blower on what is known as the Parsons system, retaining the "Dutch oven," and one was fitted with the same apparatus, but with the "Dutch oven" removed, and the grates placed beneath the boiler tubes, as is the usual practice. The grates in question, it may be said, consisted of flat cast sections fitting closely to-

gether, the only draft space being the small holes $\frac{3}{4}$ in. diameter, with which they are pierced. Pressure was supplied to the ash pit by a steam jet blower, the ash pit doors being tightly sealed. The draft holes were so small that practically no ash dropped through, the fire being cleaned through the upper door entirely. A third boiler was tested in the original condition, without alteration in any respect.

Nine tests were made in all, and although tests 2 and 9, 3 and 8, and 6 and 7 were with the same apparatus and fuel, the series was progressive in character, and it therefore seems worth while to reproduce them all.

The fuel was weighed in the wheelbarrow or platform scales. A handful from each barrow was taken, and a sample for analysis quartered down from total amount. Water was fed into the boiler by an injector, and was weighed by alternately filling and emptying two calibrated barrels, the injector taking water from a suction barrel placed below these two. The temperature of the water entering the injector was taken by a thermometer suspended in one of the feed barrels. A thermometer placed in the pipe-line gave the temperature of the water entering the boiler, and was read every hour. The amount of water entering the boiler as condensed steam from injector was calculated from the formula $S = W(h_3 - h_1) \div (h_2 - h_3)$, where S is the weight of the steam, W the weight of water entering the injector, and h_1 , h_2 and h_3 are the heat units per pound of the water entering the injector, the steam entering the injector and the water leaving the injector.

The temperature of the stack gases was taken by inserting a pyrometer through a hole drilled in the side of the up-take, readings being taken every half hour. The pressure of the steam was taken from a boiler gauge every half hour. The sample of ash was taken by the method of quartering. The tubes were blown previous to each test. No calorimeter tests of quality of steam were made, nor any determination made of steam used in blower.

The writer regrets that the calorimeter test was not made in every case. The facts that three different boilers were used, necessitating individual calorimeter connections, the difficulty of obtaining suitable supplies in that country, and the sufficiency of the tests for the immediate purpose if they furnished a fair comparison of the different conditions, must serve as his excuse. As regards the steam used by the blower, the actual determination of this point was a matter beyond ordinary testing methods. Repeated standardization of the jets, as used under operating conditions, are stated by the Parsons company to show that the steam consumption is well within 5 per cent. of the steam made.

Test No. 1.—The object of the test was to obtain maximum horse-power, and at the same time to keep the temperature of the flue gases low. The fuel used was run-of-mine bituminous coal. Just before the start, the old fire was drawn, all clinkers removed, and a new fire started. The condition and amount of fire on grate were noted, the height of the water in the gauge glass measured, and the test commenced. As soon as the test was stopped, the fire was drawn, all clinkers removed, and a new fire built on weighed fuel, and brought back to same condition as at the start. The cleaning period was, therefore, not included in the test. The clinker was easily removed from the grate. The time required for cleaning was 30 minutes.

	Moisture.	Combustible.	Ash.
Coal	3.45%	91.74%	4.81%
Ash		16.22%	83.78%

The total ash obtained, less 10 per cent. for moisture, was 585 lb. The total combustible in the ash, calculated from chemical analysis, was

95 lb. The amount of total combustible lost in ash was 1.03 per cent.

Test No. 2.—Its object was to get a comparison between the Dutch oven with a Parsons grate, and the Dutch oven with natural draught under forced conditions. The same fuel, start and ending were used as in test 1. Too rapid firing at the start, together with lack of draught caused by keeping temperature of flue gases low, resulted in the formation of a thick bed on the grate, which remained unburned. The ash in test was therefore estimated. The clinker adhered very strongly to the grate bars. The time required for cleaning was one hour.

	Moisture.	Combustible.	Ash.
Coal	1.22%	94.64%	4.14%
Ash		39.52%	60.48%

The total ash, less 10 per cent. for moisture, was 450 lb., and the total combustible in the ash was 177 lb. The percentage of total combustible of the fuel lost in the ash was 2.37.

Test No. 3.—Its object was the same as in tests 1 and 2, and the same fuel, start and ending were used as in test 1. The fire was easily cleaned, and the clinker did not adhere to the grate. The time for cleaning was thirty minutes.

RECORD OF TESTS MADE WITH COAL, SLATE AND COKE BRAIZE.

Number and kind of test.	Test No. 1, Parsons blower, with Dutch oven.	Test No. 2, Natural draught, with Dutch oven.	Test No. 3, Parsons blower without Dutch oven.	Test No. 4, Parsons blower, without Dutch oven.	Test No. 5, Parsons blower, without Dutch oven.	Test No. 6, Parsons blower, without Dutch oven.	Test No. 7, Parsons blower, without Dutch oven.	Test No. 8, Parsons blower without Dutch oven.	Test No. 9, Natural draught with Dutch oven.
Kind of fuel	Bit. coal.	coal.	coal.	Slate.	Braize.	Braize.	Braize.	coal.	coal.
Duration of test (hours).....	8	8	8.1	8 $\frac{3}{4}$	8.25	8	8 $\frac{3}{4}$	8	8
Grate surface (sq. ft.).....	52.5	56	56	56	56	56	56	56	56
Water heating surface (sq. ft.).....	2875	2875	2875	2875	2875	2875	2875	2875	2875
Coal fired (lb.)	10000	7875	11800	16400	17400	14400	15800	15800	11400
Moisture in coal (percentage).....	3.45	1.22	2.05	7.91	4.75	5.60	3.27	2.82	2.62
Dry coal consumed (lb.).....	9655	7779	11464	15119	16574	13594	15283	15355	11101
Refuse actually obtained (lb.).....	650	500	810	3261	2587	3007	3760	850	1035
Ash from chemical analysis (lb.).....	481	326	382	4894	3410	3888	4961	537	663
Water fed into boiler (lb.).....	75222	55526	93928	82784	88356	77610	93132	128952	68854
Condensed steam from injector (lb.).....	6171	4524	7800	6870	7547	6435	7794	10185	5735
Total water evaporated (lb.).....	81393	60050	101728	89654	95903	84045	100926	139137	74589
Factor of evaporation.....	1.1015	1.1043	1.1022	1.1024	1.099	1.102	1.1018	1.1072	1.1023
Evaporation from and at 212° F. (lb.).....	89654	66313	112125	98835	105397	92618	111200	154052	82219
Dry coal consumed per hour (lb.).....	1207	972	1415	1814	2009	1699	1871	1919	1388
Dry coal sq. ft. grate per hour (lb.).....	23	17.4	25.3	32.4	35.9	30.3	33.4	34.3	24.8
Evaporation per hour and at 212° F. (lb.).....	11207	8289	13842	11860	12775	11577	13625	19256	10277
Evap. per hr. from and at 212° F. per sq. ft. heating surface (lb.).....	3.9	2.9	4.8	4.1	4.4	4.0	4.7	6.7	3.6
Average steam pressure by gauge.....	106	104	104	105	104	108	107	108	107
Average temp. water entering boiler.....	154	151	153	153	156	154	154	149	153.5
Average temp. water entering injector.....	41	39	39	39	39	40	39	40	39
Average temperature of fire gases.....	580	500	567	592	430	460	435	552	554
Horse-power developed.....	325	240	401	344	379	335	395	558	398
Evap. per lb. of coal as fired (lb.).....	8.1	7.6	8.6	5.4	5.5	5.8	6.4	8.8	6.5
Evap. from and at 212° F. per lb. coal fired (lb.).....	8.9	8.4	9.5	6.0	6.1	6.4	7.0	9.7	7.2
Evap. from and at 212° F. per lb. dry coal (lb.).....	9.3	8.5	9.8	6.5	6.4	6.8	7.3	10.0	7.4
Evap. from and at 212° F. per lb. combustible (lb.).....	9.8	8.9	10.1	9.8	8.9	9.5	10.7	10.7	7.9

	Moisture.	Combustible.	Ash.
Coal	2.85%	93.91%	3.24%
Ash		24.56%	75.44%

The total ash, less 10 per cent. for moisture, was 729 lb., and the total combustible in the ash was 179 lb. The percentage of the total combustible lost in the ash was 1.61 per cent.

Test No. 4.—Its object was to obtain a maximum value for pounds of water evaporated per pound of fuel. The fuel was slate residue from the coal-washing plant. The start and ending were the same as in test 1. The low weight of ash actually obtained was due to the large amount of fine material carried over by forced blast, and to the difficulty in obtaining a fair sample of slate for analysis. The fire was cleaned at the end of the fourth hour, and after the test had stopped the clinker was easily removed. The time for cleaning was 40 minutes.

	Moisture.	Combustible.	Ash.
Fuel	7.91%	62.25%	29.84%
Ash		25.16%	74.84%

The total ash, less 10 per cent. moisture, was 2,935 lb., and the total combustible in the ash was 738 lb. The percentage of the total combustible lost in the ash was 7.23 per cent.

Test No. 5.—Its object was the same as in test

4. The fuel was coke braize, and the start and ending were the same as in test 1. The low weight of ash actually obtained was due to the same reasons as those explained in the case of test 4. On account of the low percentage of volatile matter in braize, it was possible to close the damper more than in test 4, and this accounts for the lower temperatures of the flue gases. The fire was cleaned as in test 4, requiring forty minutes.

	Moisture.	Combustible.	Ash.
Fuel	4.75%	75.65%	19.60%
Ash		39.40%	60.60%

The total ash, less 10 per cent. moisture, was 2,328 lb., and the total combustible in the ash was 917 lb. The percentage of the total combustible lost in the ash was 6.96 per cent.

Test No. 6.—Its object was to discover if braize and slate mixed in equal amounts gave better results than either one used alone. The start and ending were the same as in test 1, and during the test the fire was frequently leveled. The fire was cleaned as in tests 4 and 5, the clinker being easily removed; the time for cleaning was 40 minutes. The low weight of the ash actually obtained was explained in test 4.

	Moisture.	Combustible.	Ash.
Fuel	5.60%	67.40%	27.00%
Ash		42.40%	57.60%

The total ash, less 10 per cent. moisture, was 2,706 lb., and the total combustible in the ash was 1,147 lb. The percentage of the total combustible lost in the ash was 11.82 per cent.

Test No. 7.—Its object was to repeat test 6 and not use a leveling rod, in order to discover if the fire could be run longer without cleaning, and if better results could be obtained. The start and ending were the same as in test 1. The fire was cleaned at the end of the third hour, and after the close of the test, the clinker being easily removed. The time for cleaning was 30 minutes. The low weight of the ash obtained was explained in test 4. By filling in open spots in the fire with fresh fuel, instead of using the leveling rod, it was found that the fire was much improved. Clinker did not form so soon, a higher horse-power and a higher value for pounds of water evaporated per pound of coal were obtained.

	Moisture.	Combustible.	Ash.
Fuel	3.27%	65.33%	31.40%
Ash		23.32%	76.68%

The total ash, less 10 per cent. moisture, was

3,384 lbs., and the total combustible in the ash was 789 lbs. The percentage of the total combustible lost in the ash was 7.64 per cent.

Test No. 8.—Its object was to obtain the maximum horse-power. The fuel was run-of-mine bituminous coal. The start was the same as in test 1. During the last hour of the test the fire was cleaned and a new fire built. This fire was then brought back to the same condition as the fire at the beginning. When this point was reached, the test was stopped; the cleaning period was therefore included in the test. The time required for cleaning was 15 minutes.

	Moisture.	Combustible.	Ash.
Fuel	2.82%	93.78%	3.40%
Ash		30.76%	69.24%

The total ash, less 10 per cent. moisture, was 765 lb., and the total combustible in the ash was 235 lb. The per cent. of the total combustible lost in the ash was 1.58 lb.

Test No. 9.—Its object was to repeat test 2 to obtain, if possible, higher horse-power. The test was made at the suggestion of the boiler-house foreman, who thought he could do better than had been done, using the old arrangement. For the first four hours the fire was very good.

Very little flue dust was found in the unaltered boiler.

Conclusions.—Tests 1 and 2 showed the Parsons system was ahead in horse-power delivered and in economy, on coal alone. Test 3 showed that the removal of the Dutch oven was advantageous both in horse-power and in economy. Test 4 showed that the washer slate could be burned alone on the Parsons system, with apparently better results in horse-power and economy than clean coal with natural draught in the Dutch oven. Test 5 showed that coke braize alone would keep up steam on the Parsons system as well or better than clean coal in the Dutch oven with natural draught, though not so economically when based on actual combustible. This was all that we could expect. Tests 6 and 7 showed that washer slate and coke braize mixed, when properly handled, could be burned on the Parsons system with excellent results, both in power and in economy. Under the conditions, this test decided the adoption of slate and braize as a fuel, and this method of burning them for the whole boiler plant. Test 8 showed the capacity for forcing the boiler after alterations had been made, in case it was necessary to return to coal firing, also the relatively high economy, even under such con-

Oil Engines in a Water Works and Lighting Plant.

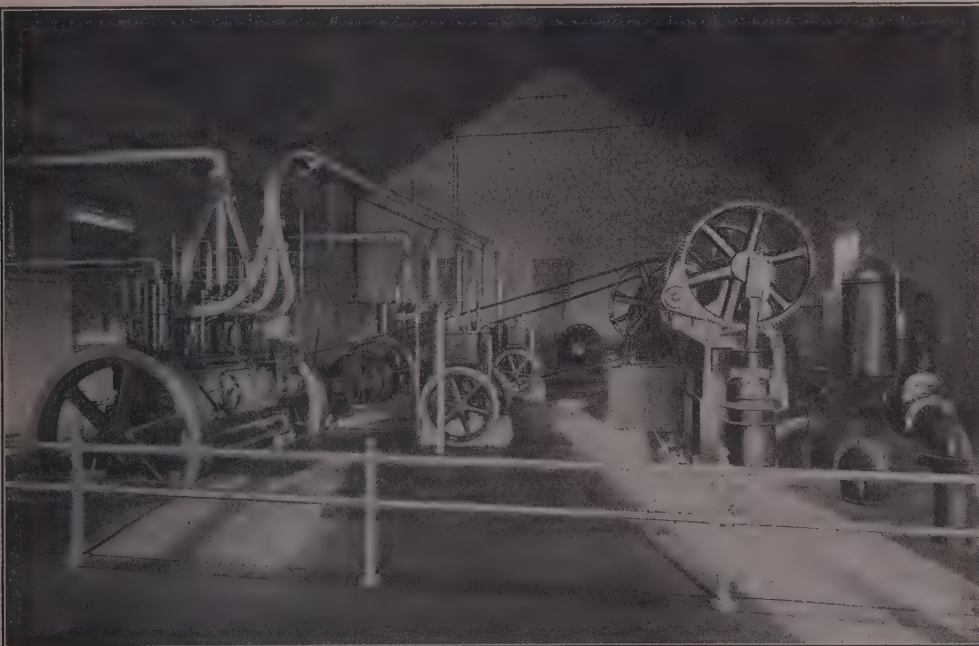
The city of Menasha, Wis., has recently completed and placed in service a pumping and electric power station, driven by internal combustion engines which have shown very economical results for equipments of small capacity. The Diesel type of engine has been used, two 75-h.-p. units being installed, each driving a 1,250,000-gal. triplex pump, while one of the engines is belted to a 50-kw. alternator for the lighting service. About 80 arc lamps are supplied for street lighting.

The entire machinery equipment is housed in a 42 x 64-ft. brick building on stone foundation, with trussed wooden roof. The building is plainly but neatly finished and extension is possible longitudinally to allow for additional equipment. The two engines are located at one side of the building and are belt-connected to the triplex pumps, which are arranged with piping connections at the opposite side. The connections for air supply and exhaust of the engines are made overhead, the exhaust pipes leading to an underground muffler box at the rear of the building. The crude oil which is used for fuel is stored in tanks having an aggregate capacity of 6,000 gal., located in a pit at the rear of the plant, and the oil is delivered to the engines by air pressure. A very low grade of crude oil is used, averaging in cost from 4 to 6 cents per gallon; an oil furnished by the Standard Oil Co., at \$0.0415 per gallon had been used and another grade supplied by The Valvoline Oil Co. at \$0.0525, but the latter has been found preferable as the disagreeable odor which is transmitted to the engine room by the cheaper oil is avoided.

The two double-gear single-acting vertical triplex plunger pumps, designed for operation against 120-lb. head, are belt driven from the engines, through friction clutches on the engine shafts, which permit the engines to be started and brought into running order before the pumps are thrown into operation. Each pump is driven by one of the 75-h.-p. oil engines, the units being operated alternately under present conditions. As pumping is discontinued early in the evening, the engine, which is also connected to the dynamo, is not called upon to operate both services at the same time.

The source of water supply is from Lake Winnebago, a lake 30 miles long by 10 miles in width, at the north end of which Menasha is situated, 15 miles from Oshkosh. The supply is taken from the rapids in the outlet of the lake into Fox River through a 24-in. suction line, the plant being situated about 500 ft. from the rapids. The pumps deliver through 16-in. connections to a 20-in. force main running to the water-tower, a distance about 600 ft. The water-tower has a steel tank 15 ft. in diameter by 65 ft. high, erected on a brick substructure with substantial stone foundation, 68 ft. in height over all. The elevation of the tank is such that pressure of 65 lb. is available in all parts of the city. While the internal combustion engines are not suited to general direct-pressure operation, they may be thus operated in case of fire for raising the pressure to 100 to 125 lb., the relief valves being set at the latter pressure.

The system of street mains has about 11 miles of pipe, including besides the 20-in. main, 16 and 12-in. feeders and 10, 8 and 6-in. mains, the latter size being the smallest used. The system is divided by shut-off gates into 43 districts, and 69 hydrants have been placed. The system is so proportioned that a number of effective fire streams may be obtained in any part of the city with the stand-pipe supply. In a test, with one of the pumps in operation, twelve 1-in. fire streams were thrown in the factory district of the city at one time, without diminution of the



Oil Engine Water Works and Lighting Plant at Menasha, Wis.

During the fifth hour, clinker began to cover the grate, cutting down the air supply. The damper to the stack was opened wider from time to time, until at the end of the sixth hour full draught was on. The bed of fuel then began to pile up on the grate, and remained unburned to the end of the test. The clinker was removed with great difficulty. The time required for cleaning was 1½ hours.

	Moisture.	Combustible.	Ash.
Fuel	2.62%	91.56%	5.82%
Ash		60.56%	39.44%

The total ash, less 10 per cent. moisture, was 932 lb., and the total combustible in the ash was 554 lb. The percentage of the total combustible lost in the ash was 5.30 per cent.

Flue Dust.—At the end of the tests both boilers fitted with the Parsons grate were examined for flue dust, and the amount found was very large. In the boiler without a Dutch oven, the flue dust was found to extend above the lower tubes; this boiler had been running one month without cleaning. An analysis of the flue dust gave 58.6 per cent. of combustible matter, 41.4 per cent. of ash and 1.95 per cent. of sulphur.

ditions. Incidentally, it also showed that the trouble frequently found with the coals of this region, namely, slagging badly on the grate, could be entirely overcome by the use of proper appliances.

Figuring on coal at \$1.24 per ton, and slate and braize at 50 cents per ton each, on a daily consumption of 63 tons, allowing for an extra man on each shift to handle the increase in refuse, and to help in the additional cleanings, if necessary, and estimating both fuels as equally efficient, the slate and braize showed a saving of over \$43 per day over coal under the former conditions. The slate and braize were therefore burned continuously until the supply of slate was exhausted, when slack coal was reluctantly substituted for it at an increased cost.

THE REBUILDING FUND started after the burning of the main building of the Rensselaer Polytechnic Institute has been closed. Residents of Troy subscribed \$41,037, while graduates and others not living in that city subscribed \$165,237.50, making a total of \$206,274.50. This is an excellent showing for a school having classes of the size of those at Rensselaer.

water pressure. There is an Engberg electric valve installed in the connection to the stand-pipe for shutting it off when operating on direct pressure in case of fire.

While the plant has been in operation barely twelve months, there are now over 100 private consumers connected. The scale of charge is 15 cents per 1,000 gal. when 300 gal. or less is used per day, and 10 cents per 1,000 gal. if a greater quantity than 300 gal. is used per day. All service connections are metered, the meter being sold to the consumer at \$7.75. The minimum charge is \$5.00 per year.

The electric lighting equipment consists of a 50-kw. National single-phase alternator from which 80 alternating current arc lamps are operated on the series system. The lamps are of 2,000 c. p., requiring seven amperes, and are operated on four circuits, each with a separate voltage-regulating transformer. The lamps are operated on an all-night basis. The actual fuel consumption of one of the engines when driving the dynamo alone is 45 gal. of oil in 11 hours. The total fuel cost is about \$2.35 per night of 11 hours for the entire number of 80 arc lamps, and will probably average about \$2 per night throughout the year. At this rate the yearly cost of fuel to operate each lamp all night will be from \$9 to \$9.50, so that the expense of opera-

Reinforced Concrete Buildings for Fairbanks-Morse Canadian Manufacturing Co.

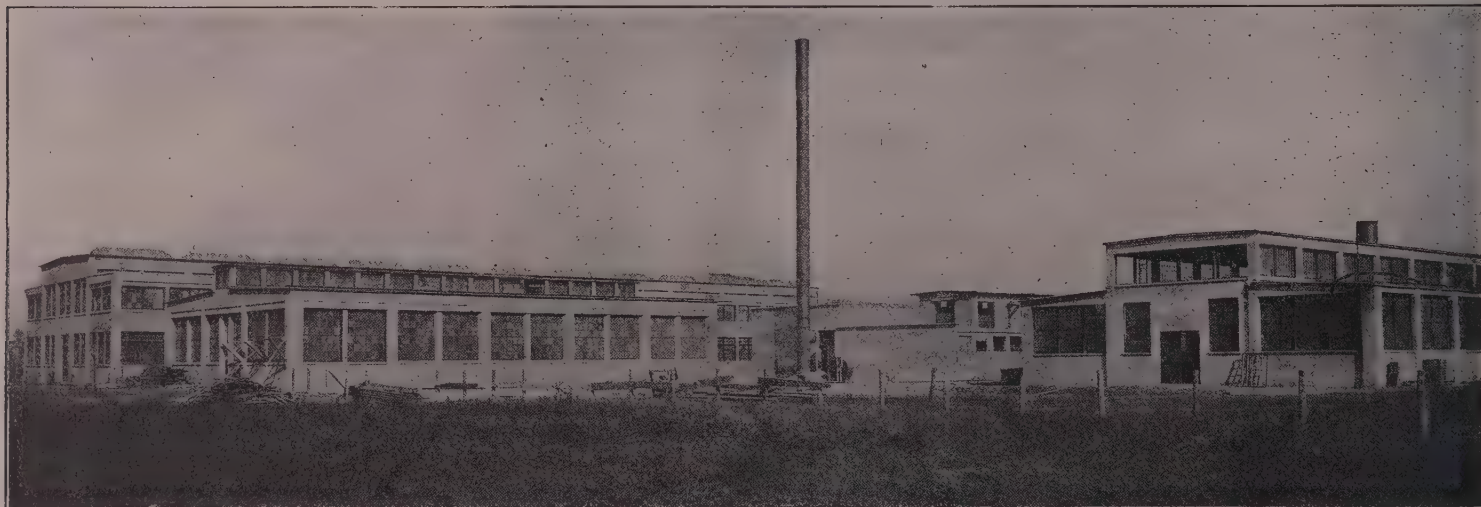
By I. Kreuger, Syracuse, N. Y.

During the last year reinforced concrete has been used very extensively in Toronto and surrounding parts of Ontario. This is due to several causes, principally the high price of brick, which in a few years has doubled and at present is \$11 per thousand.

By far the most important reinforced concrete structure in Canada is the plant of the Fairbanks-Morse Canadian Manufacturing Co., Ltd., which has just been completed. This is located on Bloor St., Toronto, and is intended for the manufacture of gas and oil engines, pumps, motor cars, etc. It covers an area of eight acres and consists of four buildings, machine shop, power house, smith shop and foundry, all constructed of concrete.

The power house has solid concrete walls, 14 in. thick, and comparatively small window area. In the other three buildings, however, the walls consist of reinforced concrete piers, the space between them being completely taken up by windows. The Kahn system of reinforcement has been used for the foundry, while the reinforcement of the machine shop, smith shop and power

the roof was 2 x 1½ ft. and reinforced with four ⅞-in. round rods tied together every 12 in. with ⅝-in. wire. The central part of the building is about 34 ft. high, and forms a shed for the crane, and on each side of this the building has a gallery floor about 15 ft. above the ground floor. The roof of these side parts is 27 ft. above the ground floor. The floor construction of the side galleries was of the corrugated type, as shown by Fig. 1, the ribs being 22 in. wide at the top and 6 in. at the bottom, and reinforced with six 11/16-in. round bars. The ribs are spaced 3 ft. center to center for the gallery floor. The floor slab between the ribs is 3 in. thick reinforced with ¼-in. round bars, 6 in. center to center. The roof over the gallery floor is carried by ribs of the same dimension and with the same reinforcement as for the floor, but spaced 8 ft. center to center. The roof slab is 3 in. thick and reinforced with ¼-in. rods, 6 in. center to center. The roof over the crane is carried by 34 concrete girders, spaced 8 ft. center to center, with a span of 53 ft. These girders are 18 in. wide, 3 ft. 10 in. deep at the center and 3 ft. 7 in. at the ends, counted from the top of the slab to the bottom of the girder. The bottom reinforcement consists of fifteen ⅞-in. round bars arranged in five rows of three each. The two upper ones in each row



General View of the Reinforced Concrete Buildings of the Fairbanks-Morse Canadian Manufacturing Co.

tion per lamp, including cost of carbons, trimming and maintenance is figured at \$18. With depreciation of plant, interest and operation charges the cost per lamp will, it is thought, not exceed \$25 per year.

Tests have indicated that the cost of operation is \$0.002 per cent. per 1,000 gal. pumped, oil being figured at the rate of \$0.04 cents per gallon. It is stated that the engines have operated smoothly and without trouble, from the beginning, and that they require no more lubricating oil, if as much, as other types of engines. The plant has recently been pumping a little over 100,000 gal. of water per day and this with a fuel cost of from 20 to 26 cents, using the better grade of oil before mentioned.

The plant was designed by Mr. George Cado-gan Morgan, Chicago, Ill., and was installed by the city under the direction of a foreman furnished by the consulting engineer. The total cost of the plant, including the engines, pumps, stand-pipe, street mains, power house and a dwelling house for the engineer, was \$105,500. The cost of the electrical system, including dynamo, switchboard, lamps and wiring, was \$9,500. The bids of contractors for laying the street mains were all rejected and the system installed by the city. The city is now contemplating the addition of a 250-h.-p. American Diesel oil engine and dynamo unit for commercial lighting.

house consists of round steel bars bent to trusses in a manner similar to that employed at the Bush Terminal Co.'s buildings, in Brooklyn, which buildings have been very fully described in The Engineering Record.

The ground where the buildings are located consists of gravelly clay, and the foundations were figured for a safe load on the soil of 4 tons per square foot. The footings were originally designed of reinforced concrete, but on account of opposition from the Building Department of Toronto, footings of plain concrete had to be substituted. The concrete in the foundation work was mixed in the proportion 1:3:5, and elsewhere in the proportions 1:2:4. Two concrete mixers were employed, one Ransome mixer driven by a steam engine, and one Smith mixer driven by a Fairbanks-Morse oil engine, both working satisfactorily throughout the job.

The most important of the buildings is the machine shop, which is 266 ft. long and 100 ft. wide, and contains a number of roof girders of more than 50 ft. clear span. This building contains two rows of interior columns spaced 51 ft. 6 in. from each other, and about 24 ft. from the outside walls. The lower part of these columns, which support the electrically driven crane, was 2 x 3 ft., and reinforced with six 1-in. round bars tied together every 12 in. with ⅝-in. wire. The upper part of the columns which support

are bent up at the ends, but the lower ones run straight the entire length of the girder. Besides these tension rods, the girders contain five 1-in. round rods in the upper part of the girder. These 1-in. rods and the ⅞-in. rods are tied together with ¼-in. vertical stirrups to the five separate trusses.

The forms for the concrete work were made of 2-in. hemlock, the big girders being supported every 4 ft. by 6x6-in. posts. In one instance, the forms were removed from one of the 53-ft. girders when the concrete had been in place only two days.

The building laws of Toronto at the time of the building operations were very unreasonable, requiring a safe compression stress in the concrete of 208 lb. per square inch; this figure also to apply to the extreme fiber stress in bending. No curtain walls were allowed with less thickness than 14 in. These building laws have, however, lately been changed to conform to more modern practice.

The machine shop was commenced in September, 1905, and was completed in January, 1906. On account of an extremely mild winter, only a few days of freezing weather were encountered during the erection, and no concrete was laid during these few days. The reinforced concrete work was designed by the writer.

The Erection of Two Large Steam Turbines.

Although considerable information has been published regarding the erection of reciprocating engines, very little on the erection of steam turbines has ever been printed. Attention may be drawn, therefore, to an article in the "Sibley Journal" by Mr. A. G. Christie on the methods followed in the installation of two Allis-Chalmers units in Brooklyn. These were the first of any size constructed by the company, and were erected under unfavorable conditions, which make the records decidedly interesting to those acquainted with steam engine installation only. The full story of the troubles is given in the article mentioned, while a description of the design of these turbines was printed in The Engineering Record of Dec. 16, 1905.

The erection of the steam turbine at the Williamsburg power house in Brooklyn was begun about Dec. 1, 1905. This unit is normally rated at 5,500 kw. at 750 r.p.m. The alternator is three-phase, 25-cycle, 6,600 volts, revolving-field type, and furnishes power to sub-stations for street railway service. The steam conditions under which this turbine operates are 200 lb. boiler pressure, 75° F. superheat and 28-in. vacuum.

At the time the erection of the turbine was begun the power house was only partially completed; no windows or doors were in place and no flooring of any kind provided. Temporary platforms, therefore, had to be erected about the concrete foundations, which rose about 25 ft. above the basement floor. All erection work was carried on from these platforms, which often had to be torn up in order to lower condenser parts into place. At the same time masonry construc-

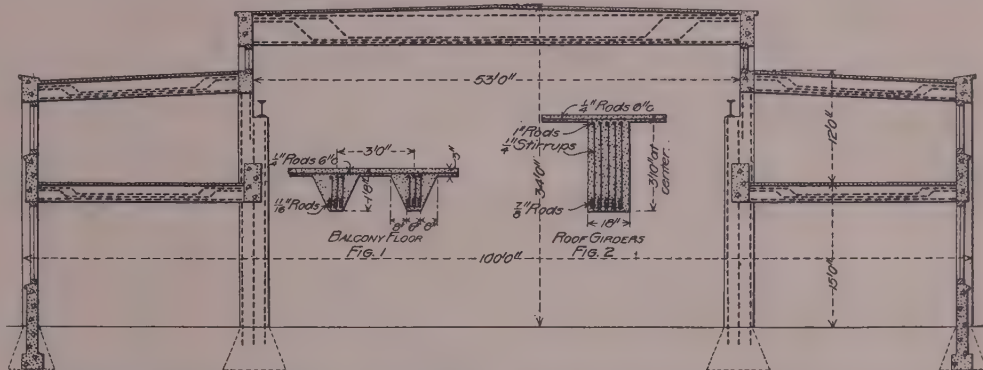
tion and steel work were carried on, above and on all sides, causing much confusion. Good use was made of an electric crane already in place and working satisfactorily, but as it was used in common with other contractors' long delays were frequent and unavoidable. The absence of heat in the building necessitated great care in handling casings to prevent breakage from the cold, which made fitting and cleaning a very slow and tedious process. Another great difficulty encountered was that of keeping dirt out of the cylinder during erection, when bricks, mortar, etc., were flying in all directions. No compressed air was available and hence all parts had to be cleaned by hand. The erection of the Williamsburg turbine was finished and was ready for use by Feb. 1, 1906, but no steam was available until about March 20.

The unit at the Gold St. power house of the Brooklyn Edison Illuminating Co. comprises a steam turbine and alternator of 5,000 kw. normal capacity at 750 r.p.m., three-phase, 25 cycles, 6,600 volts. The steam conditions under which it operates are 175 lb. boiler pressure, 100° superheat and 28-in. vacuum. The power house, which was undergoing remodeling, was in little better shape than the Williamsburg station, as no roof, walls nor floor were in place when work was begun. A strong temporary floor was soon laid around the foundations, which facilitated the work, and a roof was put on as fast as possible. A new crane had been installed, but it had not been tried out and gave some trouble at the start. The erection of this unit was not begun until May, so that the process of erection was carried on in the open building, but without any discomfort due to cold, as in the other instance.

At Gold St. all parts were delivered on cars at the Jay St. terminal, which adjoins the power house. These parts were hauled off the cars and into the power house under the crane by means

handling it, a special rig was provided for lifting the spindle with the crane. Guides were also bolted on the cylinder so that the spindle could be easily lowered into place without injuring the blading, the spindle being level when lowering down. Similar lifting rig and guide bolts were provided for handling the cylinder cover. The cylinder was then finally leveled up, taking care that the spindle was set upon a dead level, accurate ground glass levels being used for the purpose. The bed plates were then grouted in.

As this cylinder came in halves it was thought advisable to check over the hot clearances. The gland casings at the water gland on each end of the cylinder were accordingly removed and the spindle again lowered in place. In lowering the cover in place to close up the machine, the crane operator lost control of his motor and allowed the cover to drop until it rested on some blocks placed for safety on the cylinder face. Fortunately the only damage done was to bend over about a dozen



Cross Section of Machine shop, Fairbanks-Morse Canadian Manufacturing Co.



Interior of Machine Shop, Fairbanks-Morse Canadian Manufacturing Co.

tion and steel work were carried on, above and on all sides, causing much confusion. Good use was made of an electric crane already in place and working satisfactorily, but as it was used in common with other contractors' long delays were frequent and unavoidable. The absence of heat in the building necessitated great care in handling casings to prevent breakage from the cold, which made fitting and cleaning a very slow and tedious process. Another great difficulty encountered was that of keeping dirt out of the cylinder during erection, when bricks, mortar, etc., were flying in all directions. No compressed air was available and hence all parts had to be cleaned by hand. The erection of the Williamsburg turbine was finished and was ready for use by Feb. 1, 1906, but no steam was available until about March 20.

The unit at the Gold St. power house of the Brooklyn Edison Illuminating Co. comprises a

of a steam winch; hence unloading was a comparatively easy matter.

Bed plates were placed in position on the foundations and leveled up to the given floor lines. The cylinder casing of this unit was divided vertically and shipped in two parts. These were accurately fitted together before placing on the bed plates. After raising it on to the bed plates, the cylinder was roughly leveled up and the cover removed. All parts were then very carefully cleaned of paint, dirt and pieces of cuttings.

A careful examination was next made of all parts. The spindles of all large units are shipped in a special casing of boiler iron with cast-iron pedestals at either end to carry the weight, which device affords protection to the blading during shipment. The spindle, after removal from the casing, was thoroughly cleaned and placed in its bearings inside the cylinder. On account of the shape of the spindle and the care necessary in

blades in one of the last rows of the spindle. These were so badly damaged that it was decided to cut them out and replace them by new blades.

Before clearances were taken all the radiating surfaces around the throttle valves and under the sheet lagging of the cylinder body, with the exception of the bolt flanges, were covered with 85 per cent. magnesia cement, no clearances being taken until this covering was thoroughly dry.

Trials were next made to see that there was the specified clearance between the shrouds of the spindle blading and the casing, and between the shrouds of the cylinder blading and the spindle body. The turbine was kept thoroughly hot during these trials. The clearances were found to be satisfactory and the unit was then assembled ready to run.

In many of the details of construction this unit is quite different from the Williamsburg turbine. In the first place the bed plate at the steam end is carried up much higher. This end of the cylinder is not bolted down fast on steam turbines, but is left free to slide, in the direction of its length, on pads between parallel guides. When the cylinder heats up it moves out in these guides, due to the expansion of the metal body, this expansion on the large units amounting to $\frac{3}{8}$ in. As these sliding faces are at some distance from the shaft, and as the center line of this expansive force almost coincides with the center line of the shaft, it has been noted that the sliding faces have a tendency not to move out freely and thus to cause the cylinder to buckle in the middle. It is obvious that the nearer the sliding faces are moved towards the center of the shaft, the less tendency there is for buckling. It was to overcome this objection that the steam end bed plate was raised.

Instead of the fly-ball and spring type of regulator usually used on Parsons turbines, a Harting regulator was tried on the Gold St. turbine and gave good regulation from the start. At Williamsburg a single-acting oil relay system was used on the main regulator valve. A new double-

acting system in connection with the new regulator was tried at Gold St. and has worked much better than the other system. Conditions in this plant are not nearly so severe as at Williamsburg; as the load, particularly at night, is quite steady.

As the assembled generator stator was too large to transport readily, it was necessary to assemble all its parts on the ground. As these parts could not be assembled before, this work had to be done very carefully under rather trying conditions. This generator has an open frame yoke and is self-ventilating. The yoke was laid on one end in the basement and a temporary housing built around it to keep off rain and damp. The sheet metal laminations were then built up and the end head put on and bolted in place. The next problem was to turn the stator on its feet and lift it into position on the bed plates where the coils could be put in. The magnitude of this task will be appreciated when it is considered that the stator now weighed over 60 tons. However, by the use of some skillful rigging, it was safely turned and landed in place. The coils were already formed in the shops and with the very simple method of inserting these it was an easy matter to place them in the open slots, drive in the holding wedges and connect up the terminals. It was again necessary to have a shed over the generator to protect it from the weather. The rotor was completely assembled in the shops, but had suffered from exposure to moisture during shipment. This piece weighed over 40 tons. Another interesting rigging job was involved in entering this rotor in the stator and placing it in its bearings without allowing it to come in contact with the coils.

The generator was assembled complete ready to run in less than six weeks from the date the castings were unloaded from the cars. This record was beaten slightly at Williamsburg, where the generator was completed in 31 days. As soon as the generator was completely erected the drying out process was begun on the rotor, which had been thoroughly soaked in shipment and took some time to dry out. Next the terminals of the generator were short-circuited and the coils dried by passing full load current through them with the turbine running very slowly. When these were dry the generator was ready for its load.

The specifications for this unit did not state that any superheat would be used. Hence, before running under superheat it was necessary to remove the main regulator valves and give them more clearance. On starting up the position of the spindle in the casing was carefully set by means of the adjustable thrust bearing at the steam end. The turbine was then ready to run up to speed and take load.

In order to study the effect of slight changes in the blading, the angles of the stationary blades of the Gold St. turbine were altered slightly from those of the Williamsburg turbine. As expected when a load was put on, a heavy end thrust was given. An ingenious contrivance was rigged up by which this thrust could be completely balanced without loading the thrust blocks. It also allowed accurate measurements to be made within a few pounds of the actual thrust present. Many interesting experiments were made with this outfit and many useful data obtained. The end thrust will finally be balanced by altering the diameter of the low-pressure balance piston, which can easily be done on these turbines.

ELECTRICALLY DRIVEN ROLLING MILLS are coming into favor in Sweden. In 1894 the Boxholm Iron Works installed two three-phase induction motors of 70 and 100 h.-p. respectively. Since then a great many other iron works have adopted the electrical system of operation. Some of the larger plants have installations which develop over 2,000 h.-p.

The Civil Engineer.

From the Presidential Address before the Institution of Civil Engineers by Sir Alexander B. W. Kennedy, LL.D., F.R.S.

The Engineer's Status.—We have been told—and we are all very ready to believe good of ourselves—that the engineer is the most powerful instrument of civilization and progress which exists, because without him there would be no railways, no steamers, no telegraphs or telephones, no electric power to be distributed free to everybody, no motors, and hardly even the roads for motors to run on, with which latter, by the way, engineers have scarcely yet been able to furnish us. It all sounds very obvious, and we may each congratulate the other for his share in the stupendous engineering progress of the last half century. It is always pleasant to feel ourselves very superior persons, and still more pleasant to be convinced that in earning our daily bread we have been also conferring high moral benefits on our fellow men.

The glorification of our profession, while possibly useful to encourage us and keep us up to the mark, is, after all, surely due to reasoning in a circle. If we merely say that progress in engineering matters has been due to engineers, we say what is true, and what is at the same time practically the whole truth. But we have no right to assume that if there had been no railways and no telephones, no electric light and no motor omnibuses, the world would have been a whit less civilized, less moral, or less happy than it is. It would only have developed along other lines than the present mechanical ones. While engineers also are so ready to take credit for what they have done, they have to remember that they must also take their share of responsibility for it. Even without the imagination of the inventor of the "time machine," it is quite easy to conceive of a civilization developed on unmechanical lines, under which our people might have been more thoughtful, better read (in everything except newspapers), less prone to absurd excitements about what we call "politics," less ready to join in united shouting about things they do not understand, less easily persuaded to bring the State even to the very brink of war with good friends and neighbors at the bidding of some "yellow" journalist, whose malicious ravings would never have had any circulation if we engineers had not provided the printing machinery and the special trains.

I am not going to start on any discussion of the engineer with the assumption that he is the salt of the earth. But I do start from the position that, as his predecessors were responsible for starting the world on 100-lb. rails when it refused any longer to jog contentedly along on macadam, he himself must now do all he can to see that the lines laid and being laid are leading in the right directions, and not assume complacently that all roads lead to perfection simply because he has put them down. We engineers, then, because of the nature of our work and its relation to the lines taken by modern development, stand in particularly close relationship to all the activities round us, to commerce and to social life. The subjects with which we have to do, and the ways in which they have to be dealt with, bring us into intimate contact with many branches of physical science, while our modes of thought and action inevitably affect art, interfere with Nature, and even react on philosophy. Can we cultivate such an ideal that our widely extended influence shall really be for the benefit of the community, not only in giving them good railway service and cheap power, but in some wider and much more important fashion?

Engineering and Science.—In relation to science, I have always claimed for engineers a very high place, a place much higher than some of my

purely scientific friends are disposed to allow them. I really believe not a few engineers have spent their whole lives in scientific work while they were nominally only earning their daily bread in ordinary mechanical pursuits. It is not, however, so much that engineering is a science as that the scientific spirit is often the basis of engineering, and that when this is the case, engineering becomes as truly scientific as any other branch of exact research, and none the less scientific because it is also the means of making an honest living. Engineering problems differ from ordinary academically "scientific" problems, partly in that they are much more complex, and consequently more difficult of anything like exact solution, and still more because—exact or inexact—some solution to them has always got to be found. Not only must the solution be found, but it has to be translated into steel and gun-metal, as well as into £ s. d., and any mistake will entail very much more serious consequences than a controversial paper in the "Philosophical Magazine" or a letter in "Nature" pointing out a wrong estimate of terrestrial radioactivity in prehistoric epochs.

It has been, no doubt, a source of regret to many who have passed this chair, as it is to myself, that as years go on and experience accumulates, one's work comes always more and more to deal with men and matters, with general schemes and methods, even with financial means and possibilities, and less with the directly mechanical problems which fascinated us when we were younger, and for the sake of which, probably, we took to engineering at all in the first instance. This is one of the penalties of old age—of engineering old age, at all events—and it is no use lamenting it. But, speaking of the constructive part of an engineer's work and life, the part on which some of us look back as the very essence and joy of our careers, we can see that it consisted essentially of a long series of scientific problems to be dealt with, scientific questions to be answered. If the engineer has dealt with these by scientific methods, and in a scientific spirit, if he has carefully marshalled his data, deliberately reasoned from them, recognized where they were incomplete, estimated the probable effect of their incompleteness upon his judgment and upon the result, and, finally, made his decision and taken his action on the whole matter as a logical conclusion from his previous reasoning, then, I say, the engineer is acting as truly as a man of science as if he were conducting a laboratory research with appliances and methods of exactness and precision unknown in actual professional problems.

But a word of caution—unnecessary to the experienced, but sometimes necessary nearer the start. The mere use of formulæ or of exact calculations of any sort is not in itself scientific. That man shows far more of the scientific spirit who recognizes when his data do not allow of the use of any exact formulæ, and who therefore reasons with what may be called mathematical common sense, than the man who tries to force the facts to fit a class-room formula, and arrives at a result which satisfies the formula without recognizing that it bears no relation to the facts. The scientific engineer may use elaborate calculations or he may not; a most important part of his science lies in judging whether to use them or not. Conversely, the man who calculates elaborately may be working scientifically or he may not. The mere calculation is not scientific, and in certain cases may only be a cloak to essential defects, both in scientific method and in technical perception.

The engineer, of all men, should have the earliest opportunity of working himself free from the youthful leading-strings. From the day that his pupillage ends until the last day of his engineering life he is always face to face with the fact,

that there are half a dozen ways of doing everything, and that the half-dozen ways are more or less equally good. I suppose most of us carried our boyish cocksureness right through our pupillage, and left our first shops or offices with a notion that everything ought to be done exactly as it was done there. But the notion was dispelled with an almost overwhelming shock when we found out that elsewhere no one cared in the least what our people had been doing, but got the same results by quite different methods. The more we see of engineering work the better we know that none of our problems has one single solution, that all of them can be worked out to the same end in many different ways, and that it is very seldom indeed that, except as to some small detail, any one method is so much better than the others that it has any special claims to be called the right method.

Art in Engineering.—To what extent do engineer and artist come in contact? It can hardly be denied that there are points which at least ought to be points of contact in their work, although their paths seem frequently to intersect rather than to be tangential, and the intersection is too often at 90 deg.! When engineering structures were confined to masonry bridges and pumping-stations the matter was comparatively simple. It was difficult to make a stone bridge which was structurally efficient and actually hideous at the same time, and many of the older structures of this type left nothing to be desired by way of beauty of line. Whether a castellated or a quasi-Gothic building was the most suitable form for a Cornish engine-house may be questioned, but, at any rate, many of the pumping houses which once covered the country were not eyesores, and along with a not unpleasing exterior they combined complete internal suitability. It seems a little odd to us now—but it was certainly prompted by worthy motives—that even the machinery inside the houses, was designed on architectural lines which were at least supposed to be lines of beauty. Even in the time of my own apprenticeship it was universal for bed-plates, entablatures, and other large castings to be finished at their corners and angles with mouldings more or less carefully designed according to classical models. Even moving parts, such as the bosses of cranks, were ogeed round their edges, and no connecting rod of a stationary engine was considered finished without a double ogee ring round the middle of its length. Some of these details were survivals from cast-iron construction applied to a forgeable material, but they all died hard, like many less harmless customs. Penn's oscillating engines in the Thames steamers, which were at work until only a few years ago, had their cylinder cover-nuts of gun-metal, each made with a turned ogee moulding at their base like a fixed washer; and the entablatures of the same engines were wonderful in their wealth of detail.

As regards machinery of every kind, from marine engines to sewing machines, we have come to recognize that at present our business is to use the material in the place where it is wanted, and of the form best adapted for the work which it has to do. Between moving machinery and architectural structures there is no analogy; and to apply to the one the classical rules or conventions of the other, as was once attempted to a certain extent, is surely a mistake in art as well as in engineering, and the eye has now recognized this. But it would imply, I think, a very narrow range of perception of things beautiful to deny a beauty of a genuine kind—although neither classic nor romantic—to an express locomotive, or to a great marine engine as it stands in the erecting shop. We used to compare the hard outline of the steamship, with its clumsy funnel and abortive masts, with the graceful lines of the three-master and the beautiful forms and color

of her sails. But even already, although steamships are things as yet of our own generation, now that they have cut themselves adrift from all suggestion of imitation of their predecessors, every one recognizes that there is a dignity in a "Dreadnought" which is almost majestic; and that the modern liner, properly handled, forms really as fine a subject for a picture as a full-rigged ship, although naturally the pictures are different.

Engineers nowadays have so little chance of building stone bridges that I can hardly mention them as modern engineering works, but the great masonry dams of such undertakings as Mr. Mansergh's Birmingham water works challenge comparison with any architectural structures. Unfortunately, few people see them, and the public generally are not disposed to judge us by Craig Goch or Caban Coch. Perhaps our greatest difficulty in this matter is with our steel bridges. They are unavoidably so much in evidence that even "the man in the street" considers himself fully competent to form, and therefore to express, an opinion about them. I need not say that "the man in the street" is really able to do nothing of the kind, except, of course, to express an opinion. None the less it behoves us to take care what we are doing, not for the sake of the mere surface opinion of to-day, but in order that, by the time our work has become ancient, it may also be considered worthy of the respect due to age, and not the mere survival of an early Victorian period in the youth of engineering.

The carved mouldings and details which lend so much beauty to a structure of stone, are apt to impress us only as "cheap and nasty" when reproduced in cast iron. Similarly, the curves and scrolls of a Gothic pattern, if imitated in malleable iron on a structural scale, do not give the idea of beauty, but merely of material used in a wrong way. The matter is not really one for argument; we must just accept the situation as it stands, and be thankful that we are not expected to be definitely ornamental as well as useful.

At the risk, however, of being considered a Philistine, I feel bound to say that I do not consider a well-designed lattice girder—such, for example, as those of the Charing Cross bridge—to be in itself ugly. I admit that the old Charing Cross Station roof was an eyesore from the river, as is the present Cannon Street Station roof; but that is another story, and not at all an easy one to deal with, for from inside there appears nothing to be said against these structures aesthetically. But as to the bridge itself, I make bold to say that after another forty or fifty years, if the bridge is still in its place, it will be recognized that a straight line is not in itself hideous—which seems to have been recognized long ago in Athens. And if it be once admitted in principle that a girder bridge, in spite of being straight, may be looked at without pious horror, the critics may cease to affect displeasure, and even come to regard such structures as simple and straightforward, and in their whole effect not at all unpleasing. I speak, of course, of the girders themselves, and not of such cast-iron humps between them above the piers as there are at Cannon Street, for which, I confess, I can suggest as little justification as I can for the shape of the sometimes admired arches of Westminster Bridge.

We expect architects to consult and employ engineers to help them over structural difficulties, and we may even scoff when they come to grief for not doing so. They are, on the other hand, quite entitled to turn the tables on us when they see that an engineer has put up a hideous barn which they could have transformed into a pleasing structure by their own special knowledge, and by that sense of form which it has been their chief business to cultivate, while we have been working at bending moments and breaking loads.

I have spoken of engineering in relation to art; it would, perhaps, be put down to cowardice if I

did not say something of the relation of engineers and engineering to Nature, especially as my mountaineering colleagues at the Alpine Club occasionally try to convince me that if I had any conscience I should renounce engineering altogether. We are sometimes guilty of disfiguring Nature, I believe and regret. What is the extent of our guilt? Our interference with Nature—that is, especially with natural scenery—comes practically under two heads—the erection of works for the utilization of water, either for use in cities or for power, and the construction of railways in mountainous or other beautiful districts.

The first is the easier to deal with. The conversion of upland valley bottoms into lakes by the construction of dams seems to me to be out of court at once. I am not inclined to admit that to cover boggy peat and with blue water is doing any harm to Nature, or that a fine masonry dam is an eyesore. Moreover, if it is required for the supply of water to cities which could not obtain the water otherwise, it is a "work of necessity and mercy," and there is no more to be said about it, unless the engineer does his work with wanton disregard to all appearances, which, I believe, is never alleged. Water-storage for power purposes can hardly be put upon quite so high a level, no doubt, and unfortunately such works are generally accompanied by pipe lines, which, it must be owned, are not things of beauty. But if the net result of the whole is to give employment to hundreds of men in places where hitherto no one could maintain himself, and to utilize natural sources of power, hitherto neglected, for doing useful work on the spot where they exist, then I think an impartial arbitrator would say that the schemes were justified, even at the expense of ruling a straight line on the landscape. I admit that tu quoque is not an argument, but some of us who love the hills best find, I think, that the scar along the hillside made for a deer road is every bit as disfiguring in itself as a pipe line, while it is infinitely less agreeable in all its suggestions. It may cheer the guilty engineers a little to think that, if there is anything iniquitous in the utilization of water power, then *à fortiori*, our whole nation is involved in the guilt accompanying the utilization of its coal fields, compared to which the construction of a few dozen pipe lines is a quite microscopical offence.

Engineering and Law.—With another profession, that of the law, we are brought by our daily work into very close connection, so close that in many matters it is necessary for the engineer to carry out his work in the most strictly legal spirit, however undesirable it would be for him to be "his own lawyer." All engineering work of importance is carried out according to both a specification and a contract. An engineer prepares the specification and is practically responsible for the contract, while very often other engineers—from the manufacturing side—accept both documents and undertake to work to them. There is little doubt that the more strictly legal, which means in this case equitable, the conduct of both parties is, in reference to these documents, the less is the probability that the aid of the purely professional lawyer will have to be called in later on.

On the manufacturers' side there is one chief and simple, but absolutely necessary duty to perform in reference to these documents—namely, to read them. The duty is as simple and as obvious as "keeping your eye on the ball" in another phase of existence, and is just as often neglected. Hence many tears. If the contractor or manufacturer is dealing with a responsible and experienced engineer, he may be sure that the documents are intended to mean what they say, and that—barring mistakes—they do mean it. If, therefore, he finds that he cannot do what he is asked to do, there is nothing to be gained by slurring it over. The only means of avoiding

trouble is the raising of all doubtful points before the work begins, so as to get them settled. If, on the other hand, the contractor is dealing with an irresponsible or inexperienced engineer, and no doubt there are such, it is all the more necessary that he should know exactly what he is asked to do. For in that case there may be meanings in the documents which only careful reading will discover, but which will certainly be taken advantage of, later on, against the contractor himself.

On the side of the engineer who draws up the specification, it is surely his duty, after drawing it up, after stating as clearly as possible his requirements, to endeavor to go through it from the point of view of the contractor, and make sure that there can be no reasonable doubt of the meaning of the words or phrases he has employed. This is every bit as true of the specification as of the contract; but whereas with the latter there is always legal help available, with the former the engineer has to trust to his own power of exact expression in saying just what he wants, and no more and no less than he intends to have.

The question of how much or how little to put in a specification is one about which no very general rule can be laid down. Naturally, much depends on the engineer, on the contractor or manufacturer, and on the nature of the work. But first and particularly it is the duty of the engineer to define exactly what results he wishes to obtain. If he is unable to say what he wants he can hardly be the right man for the work, and had better leave it alone. He can also say, quite exactly, the nature of the materials he requires to be used. In the majority of cases he can also say in what way the work is to be carried out, what machinery or apparatus or appliances are to be used, and how they are to be arranged or applied. Or, if there are several ways in which his requirements can be met, he can indicate one of them and leave the contractor to suggest others. No doubt cases arise in which the requirements are such as can be fully met by certain methods or appliances only of a certain particular manufacturer or contractor, but in general a specification cannot be too full—it can certainly never be too clear—in dealing with general requirements and results. But in details it may very easily be too full, and no greater mistake can be made—nor any mistake more likely to lead to vexatious litigation later on—than to crowd up a specification with detailed particulars as to matters which every competent contractor or manufacturer can carry out equally well in his own way. I would therefore put, as the characteristics of a good specification, definiteness and clearness always, fulness as to requirements and as to guarantees, freedom and openness as to those details and methods which are largely matters where contractors have had very varying experiences.

Personally I have very strong views as to the inadvisability of making an engineer the arbitrator in relation to his own specification, although I know that some public bodies have different ideas. But even where the engineer is not the final arbitrator, there are sure to be many points of detail in relation to the carrying out of the work according to the specification which he solely will have to settle. And in these it is very desirable that his attitude should be, as far as possible, that of an arbitrator rather than of a party to a dispute. It is really here that the special importance of definiteness and clearness in the original wording of his specification comes in. If he has said exactly what he wanted in terms which could not reasonably be misunderstood—if they had been reasonably and carefully read to start with—he can make his decision as fairly as if he were an arbitrator. But if his specification

has not been clear, or has been insufficient to start with, his decision must necessarily be colored by his own unexpressed intentions, his own view of what he meant; so that, although honestly given, it may not be by any means certainly the decision which an arbitrator would have given under the same conditions. Strictness, or even what is called severity, in a specification is not in itself against the interest of the contractor. As long as he can see what is wanted it is his business to prepare for it. If the contractor presumes on the engineer being slack in construing his requirements, that is his fault, and he is rightly penalized when it turns out that he has caught a Tartar. But a carelessly worded specification, or one in which important requirements are slurred over or only indicated inferentially, is unfair to the contractor, is unworthy of the engineer, and is likely to lead both into trouble as well as to result in unsatisfactory work.

With ordinary commercial life, every engineer stands in very close touch—the manufacturer, of course, directly, the consultant indirectly, but hardly less intimately. We shall not go wrong, any of us, if we can only make up our minds that, as to our work—whether hand-work or brain-work, metal-work or paper-work—its quality is the first thing to be considered, and that, as to ourselves, no amount of profit is worth having if it is obtained by us as mere money-getting machines, and not as gentlemen. We are rather fond of talking loosely of engineering as a "profession." I am not sure what authority is entitled to say whether engineering is or is not a profession. It must be a very young one certainly, if it is one at all. But by all means let us call it a profession, and then let us do our work accordingly. I fear it must be confessed that with some engineers things have occasionally not been thought unworthy or improper which, although not in themselves dishonest, would be impossible among lawyers or doctors, which ought to be impossible among gentlemen, and which would be impossible among ourselves if our organization were as complete and our etiquette as strict as in the older professions. I ask members of this Institution to keep before them, for their own sakes, as well as for the honor of the Institution, an ideal of business or professional conduct at least as high as exists in the older and recognized professions of law and medicine, even although honorable behavior cannot, among us, be enforced by legal penalties or disqualifications. Even the warmest admirer of free imports in the physical world will admit that in the world of ideas—which, after all, is the real world—there are some importations which we would willingly prohibit altogether. And for us engineers such an import (I hope it is not, after all, a native manufacture) is represented by the notion that an engineer may remain a gentleman in his private capacity while in business affairs he habitually sets "smartness" before honesty and money-getting before everything.

Engineering and Labor.—A more subtle difficulty connected with the business side of our engineering life arises in the relations between the two great sections of engineering, which one may call the contractual and the consultant. Each branch is honorable in itself—neither more than the other; many excellent engineers also have changed from one to the other for their own advantage, and to the advantage of engineering also. But now and then an attempt is made by honorable men, and in all honesty, to be contractors and consultants at the same time. Every such attempt, so far as I know, has ended in failure, and I am sure that the combination is to be deprecated. It may be a counsel of perfection, but I would go so far as to say that a consultant ought not even to hold shares in any manufacturing company with which there is the slightest

chance that he may have to do in his professional capacity. There are plenty of things in which we can invest money without being in the least hampered by a self-denying ordinance of this extent.

It goes without saying that the relationship of engineering work to the industrial life of the country is of vast importance. Directly, engineers are very large employers of labor; indirectly, through our railways and manufactures, we must be responsible for the employment of more "labor"—using the word in the popular sense—than any other set of men. It would obviously be impossible for me, in the few minutes at my disposal, to discuss here our industrial relationships. Only let me express an earnest wish that, for the sake of the well-being of the country as a whole, and of everybody connected with engineering, from the fitter's mate to the past-president, and for the sake of the work which we are carrying on and carrying out, these industrial relations be kept out of the unstable whirlpool of politics. It is quite difficult enough to manage our own affairs, to see fair all round as we should wish to do, to keep the relations between man and man friendly and honorable, and at the same time those between employer and employed strict and business-like, without the interference of gentlemen who can see no virtues on one side and no faults on the other, and whose only remedy for all the troubles which now exist is the establishment of a state of war under conditions of maximum irritation and ill-feeling.

Would it not be possible to take advantage of the present time, when beyond the usual local differences no great industrial disputes are pending, when the relations between employers and employed are, taken over the whole country, friendly and cordial, and when business generally is becoming more prosperous, to follow up the good beginnings which have already been made, and which have been so eminently successful in their practical working, and to take still more extended steps towards the establishment of joint trade committees, appointed specially to act when required as arbitration tribunals, under experienced leaders whose names would command universal confidence? Hitherto we have too often tried arbitration only when a fight was imminent, and when feelings were already strong on both sides, when each side had made up its mind vigorously, and when for either to give way meant some injury to amour propre. Surely that is a wrong way altogether. Is it impossible for us, in a matter where both personal and public interests are so much involved, to have some reasonable foresight? Let the people who may be opponents at some future time, but whose highest interests as citizens must always be identical, however different the two sides of the shield may look—come together in time and not only discuss, but arrange the best means they can devise for dealing with and settling disputes of all kinds as they arise—before they arise. We know perfectly well that disputes will arise, and we know just as well that only in very exceptional cases is either of the two sides likely to be entirely right. At present the two sides say "can't" and "must" to each other until they are out of breath, and angry. How much better if machinery existed which had been created by both parties together, in which both had reason to trust, which could take up and settle the difficulties before the stage of mutual recrimination and vituperation had even commenced. But it is necessary in the very first place, necessary before any really useful steps can be taken, that each side should admit frankly and fairly the possibility that it may not be entirely right, and that the conclusion which is most to its apparent interest may not be the right one or the most desirable one. There are times when the employers must put up with diminished profits—they have

no divine right that everything should remain as it has been when it has been most satisfactory to them; there are times when the employed must put up with reduced wages—they have no divine right to a permanent continuance of the wages they have earned when trade was at its very busiest. Unfortunately, it is very difficult for all of us to believe honestly, or even to admit for argument's sake, that a really just fate would ever mete out to us a less satisfactory result than the best we have had, and we are all apt to think that "bad times" ought rightly to affect most other people before they should touch us. As to certain mischief-makers whose avowed object is to set employers and employed by the ears, to make them believe that they are natural enemies, whose view of the State is limited to the narrow horizon of what they are pleased to consider their own "class," they must be left to the common sense of the members of the State generally, and of their own "class" in particular. After all, it is to be hoped that the majority of citizens are neither doctrinaires nor "professional" politicians, but men wishful that the State should prosper through the common prosperity of all its sections and men who recognize, I hope, that every section has duties as well as rights, while it has at the same time rights as well as duties.

Future of Engineering.—It would appear as if "invention," whether in the popular acceptance of the word, or in the sense of painstaking working out directed to an object of immediate importance, constitutes such a disturbing influence in mechanical or engineering evolution that it is useless to attempt prophecy on evolutionary lines. It is, I am afraid, still more useless to try to forestall the future by trying to do to-day what one thinks may possibly be done by others ten or twenty years hence. Such attempts have been made several times, and much as we may admire the spirit of the attempt, we cannot, judging by results, admire its wisdom. The building of the Great Eastern, whose history is a pathetic tragedy in engineering, which had to be broken up for scrap almost in sight of the Carmania and Caronia, is a case in point which will occur to every one.

But once discovery, or invention, or patient investigation has created its new species, be it material, or method, or machine, the thing itself falls inevitably into line, and has to submit to the operation of certain general tendencies, which people are fond of calling "laws." It must either work out its success along lines which can be fairly well predicted, or it will fail to work out any success at all, fail to fall in with the general scheme of the (mechanical) universe, and disappear.

But here again, unfortunately, "artificial selection" sometimes comes in, and plays havoc with the "laws." For although it may be pretty safely said that no invention becomes a great success that is not sound and useful essentially, it must also be admitted that every now and then an invention of distinct utility disappears altogether—failing either through want of money or push on the part of its friends, or by too much money and push on the part of its rivals.

Once the species, however, has outlived such difficulties, its further development or improvement generally follows along more or less intelligible, but somewhat complicated lines. Simplification, for instance, almost invariably comes, and may be carried to the furthest point possible, short of impairing the completeness of the work. But, on the other hand, in certain cases where extreme completeness is the thing absolutely essential, the developed machine is less simple than the original one. Similarly with cost; a development which tends to reduce price is the usual one, but considerations as to the probable life of a machine, or the desired life of any particular machine, the probable duration of the de-

mand for its products, its cost of maintenance, etc., may outweigh in many cases the question of first cost, and make the improved machine much dearer than the original one. Where a machine is devised to perform some special function, its merits may be shown either by the cheapness with which it carries out its function, or by the excellence of the work which it produces. Here again the two directions of progress may be incompatible, and the particular direction in which progress will occur will be determined by the circumstances of the case.

Another direction of development, especially in connection with mechanical affairs, is no doubt the increase of directness, the avoidance of transformation, and the decrease in the number of separate stages by which a required result is obtained. We burn coal, pass a part of the heat of combustion to water through metal which absorbs some of it, and utilize the balance for evaporation. We use a portion of the energy so gained by the steam in doing mechanical work, and a portion of this portion is transformed into electrical energy. But electrical energy as such is required for very few purposes, so that in general some percentage of the electrical energy is again turned into mechanical work, and even of this only a small part is actually useful—or it is turned into heat, of which a still smaller fraction appears as light, and is used as such. I read a paper on this subject before the Royal Institution some thirteen years ago, in which I pointed out that in the case of electric light much less than one per cent. of the whole heat of combustion with which the process started appeared actually as the useful and saleable commodity—light—at the end. Electric lamps are more economical now, but the proportion still remains ludicrously small.

It would seem natural to hope, therefore, in looking forward, that one of the chief directions in which the engineers of the future will carry out successful work will be that of increasing directness, avoiding transformation, and greatly increasing the efficiency of whatever transformations remain necessary. Engineers hardly need the warning, but the public certainly does, that so-called "improvements" in this direction, made without knowledge of what existing efficiencies are, or which embody physical impossibilities as soon as they are reduced to figures, are not schemes in which to invest money or promising real engineering development, to say nothing of commercial success.

But again, the actual happenings of the case have to a considerable extent falsified the idea that progress was to be in the direction of reduced transformation. Some of the older electrical works, supplying direct and untransformed current on a large scale over moderate distances, are to-day selling or utilizing over 90 per cent. of the energy which they generate. But geographical and other conditions have rendered it necessary, in many cases, to choose power-house sites so distant that high-tension transmission, and consequently one or more sets of transformation losses, were unavoidable, so that often the 90 per cent. is reduced to 80 or even 75 per cent. Oddly enough, there appears at the moment to be a tendency to forget, in the joy of triumphing over distance, that the transformations, although forming an integral part of excellent systems, are in themselves purely evils, however unavoidable for the present. It is to be hoped that the next decade may see the development of methods which will retain the advantages of the high pressure for transmission, without the very serious drawback in loss of efficiency which at present accompanies it.

I am very conscious that the survey which I have attempted to put before you this evening of our own work in its exterior relations has been a very incomplete one. I have not been able even

to mention our relations to the profession of medicine through the great group of engineering works which have to do with water supply and sewage disposal. Works of that kind and some others are also intimately connected with municipal life, unfortunately sometimes with municipal politics as well. A discussion of the relationship of the engineer to the public—who-wish-to-move-about (it is a pity that our language does not lend itself to the manufacture of compound words like the German) is a matter to which alone an entire address might be devoted. Telephony and telegraphy bring us into contact with public departments, and occasionally, it is said, give us some little experience in the use of the material known as "red tape," which, in common with all other non-technical materials (such, for example, as shellac and string), is an abomination to the really mechanical mind and fingers. Literature, I am afraid, disowns us; I have even heard it denied that the contents of the engineering part of my library could be called "books" at all in any worthy acceptance of the word. That was, no doubt, the extreme view of a very superior person. Still, we may claim credit for our technical literature as literature at least in the one respect that we use words—often inelegantly, no doubt—to express our ideas as clearly as possible, and not as indications of the absence of any ideas or of their extreme haziness when they exist. This one quality I hope we have in common with the highest in literature, even if our ideas themselves are despised as merely commonplace and mechanical.

The Blackbrook Dam, Loughborough, Eng.

The Blackbrook Dam, built across the Blackbrook Valley in connection with the water supply of Loughborough, Eng., was completed last September. It is a masonry and concrete structure, 525 ft. long, 65 ft. thick at the brook level, 14 ft. thick at the intended water level and 108 ft. high measured from the bottom of the foundation trench to the top of the parapet. The difference between the brook level and that of high water in the reservoir is 65 ft. and the bottom of the foundation extends 30 ft. below the brook level. Six arches of 25 ft. span each carry a 9-ft. roadway across the dam and provide overflow openings. A tail pond prevents scouring at the toe of the dam during heavy floods. The capacity of the impounding reservoir is 506,000,000 imp. gal. Water is taken from it through valves at various levels in a valve tower.

When the excavation for the foundation had reached the required depth it was found that past volcanic action had crushed the rock bed and formed numerous fissures through which water passed away freely. More than fifty springs were also found in the bottom of the excavation. Accordingly a safety trench was carried down to a depth of 55 ft. below the level of the brook, cutting off the flow from the fissures and springs. Similar precautions had to be taken on the hill-sides with the added difficulty that in dry weather there was no water to indicate the dangerous spots. Temporary dams and deep pits were kept filled with water to show the points of leakage. On the west hill some particularly troublesome fissures necessitated driving headings under the hillside.

The contract was let in Feb., 1900, to Messrs. H. Fotherby & Son, who carried on the work till Feb., 1902, when on account of trouble over the safety trench and the death of Mr. C. T. Fotherby, who had acted as superintendent, the work was taken over by the water-works corporation. Mr. C. E. Robinson was placed in charge under the direction of Messrs. Geo. and F. W. Hodson, M. M. Inst. C. E., and the work was carried forward to completion. A detailed account of the Blackbrook Dam recently appeared in "The Surveyor."

The Power House of the Winona Interurban Railway.

A power station has recently been built from the plans of Messrs. Sargent & Lundy, of Chicago, for the Winona Interurban Ry., which had to satisfy rather unusual conditions. This railway is an offshoot of an educational enterprise in Indiana, the Winona Assembly and Summer School Association, somewhat resembling the Chautauqua Assembly in New York. This association owns a 2,100-acre park at Winona Lake, two miles east of Warsaw, where it conducts a trade school throughout the year, and during the summer nearly half a million people attend the summer meetings. Some time ago the association organized a branch company to construct an electric railway to Warsaw, which proved financially successful as well as a great accommodation to the people living at the park, about 1,500 in number, and the summer visitors. It was found, however, that better transportation facilities were needed than the steam railways and this little line could afford, and consequently the association organized the Winona Interurban Railway Co., to construct lines from Warsaw north to Goshen, 25 miles, south to Peru, 45 miles, east to Fort Wayne, 38 miles and west to Valparaiso, 65 miles. The first of these lines is now in operation and the second will be finished in a few months. It may be added that the capital stock of the company is but \$15,000, all construction being paid for by a bond issue, and the cars do not run Sundays, which has not prevented the net earnings largely exceeding the fixed charges.

The power station, at Winona Lake, has been designed so that it can be extended without interfering with the operation of the portion already in use, and this condition has influenced the general arrangement of the building and its equipment. The building is of brick and steel, with a cinder concrete roof. Transverse fire walls divide it into a coal storage room containing an elevated standard-gauge spur from the Pittsburg, Fort Wayne & Chicago Ry., a boiler room and an operating room, which has a basement for the high-tension bus structure and for a lavatory. Near the center of the boiler room a Weber steel-concrete chimney rises 175 ft. above the floor. The chimney is 8 ft. in inside diameter and rests on a concrete foundation 22 ft. square.

On each side of the chimney, with their rear walls a few feet distant from the fire wall between the boiler and operation rooms, are located two Babcock & Wilcox water-tube boilers designed for a working pressure of 150 lb. Each contains 3,000 sq. ft. of heating surface and is rated at 300 h.p. The furnaces are hand-fired and are fitted with Kelly shaking grates. In order to obtain the best results from bituminous coal, which it was intended should be burned, the furnaces are equipped with coking ovens. The location of the concrete chimney with reference to the boilers permitted comparatively short flue connections. These are suspended above the boilers on a steel framework, and are built rectangular in shape of sheet steel 3/16 in. thick. Hand-operated dampers are located in the connections to each boiler as well as in the main flues on each side of the chimney.

In the space immediately in front of the chimney and between the two sets of boilers are installed two boiler feed pumps, two low-service pumps and a Cochrane feed-water heater capable of handling 52,000 lb. of water per hour. A steel framework which supports the heater several feet above the floor serves also as a support for the numerous pipes leading to and from the pumps and heater. The boiler pumps are of the horizontal outside center-packed plunger type, and the low-service pumps are of the piston pattern. In ordinary operation of the plant the low-service

pumps obtain their supply of water from a pumping basin outside the building and discharge into the Cochrane heater and into the circulating coils of the water-cooled high-tension transformers, and in addition in starting up the engines the duty of supplying pumping water to the condensers is imposed on them. All of the pumps and the engine of a steam-driven exciter exhaust into the feed-water heater, and the exhaust of the condenser pumps may also be turned into it. In addition to the steam exhausted into the heater, considerable economy results through piping into it the return water from the transformer cooling coils and by draining into it all of the steam traps connected to the piping system. The boilers have connections to a common blow-off header which is carried along the floor of the basement of the operating room. This header, which is 3 in. in diameter, leads into a cast-iron blow-off tank located under the ground near the east wall of the boiler room, which tank in turn is drained into the lake.

Steam from each boiler passes through a 6-in. main into a 12-in. steam header supported by brackets on the operating room wall about 11 ft. above the floor of the boiler room. This header is divided into two sections by a 12-in. gate valve at its central point. Mains from two of the boilers and a main to one of the engines are connected to each section. The main header is supported in a manner that allows considerable expansion and contraction. At its central point near the gate valve it is anchored firmly to the supporting bracket. At the other four brackets it rests between roller bearings and is held firmly in position by a pressure on the top obtained through heavy coil springs below the supporting bracket. The manner in which the large steam mains are brought to it also allows of considerable movement without inducing strains in the piping. Partly with this idea in view, the header is dropped down several feet below the top of the boilers and the large steam mains are brought to it by long, sweeping bends. Each of the boiler leads has one horizontal and one vertical bend in it, while the engine supply pipe contains two vertical bends of large radius. These latter mains, which are 7 in. in diameter, pass upward through the adjacent wall and into a separator immediately over the throttle valve of the engine. With the exception of the condenser pumps, which obtain their steam direct from the engine mains, all of the steam auxiliaries are connected to a 4-in. auxiliary steam header located directly above the main steam header, which in turn is connected to both sections of the main header.

The probability of future extension of the station determined to a great extent the arrangement of the apparatus in the engine room. The generating units were of course placed as close to the boilers as possible, and the switches and transformers for each unit were located opposite the generating units to maintain the unit system followed from the boilers to the high-tension buses in the construction of the station. The exciters, the sub-station apparatus and the switchboard, however, were located near one end of the building in such a position that when the contemplated future extension is made to this end of the building they will be centrally located. The relative location of the switchboard and the auxiliaries, moreover, places the switchboard operator in a position from which he can observe the behavior of the exciters and the rotary converters.

Electrical connection between the different units of the station is made by means of high-tension buses located in an L-shaped brick and concrete bus structure in a portion of the basement of the operating room.

Each of the two generating units installed at the present time consists of an Allis-Chalmers Corliss engine direct-connected to a 600-kw Allis-Chalmers generator. The engines are of the

horizontal, cross-compound type with cylinders 20 and 42x48 in. They are designed to be operated with 140 lb. indicated steam pressure and at a speed of 94 r.p.m. At 850 i.h.p., which is their most economical loading, and with a vacuum of 26 in., the guaranteed consumption is 14.1 lb. of dry steam per i.h.p. In emergencies, however, they are capable of developing continuously 1,500 i.h.p., and they will care for momentary loads of 1,700 i.h.p. It is interesting to note in this connection that the first engine installed upon being started for the first time was operated continuously for 161 hours.

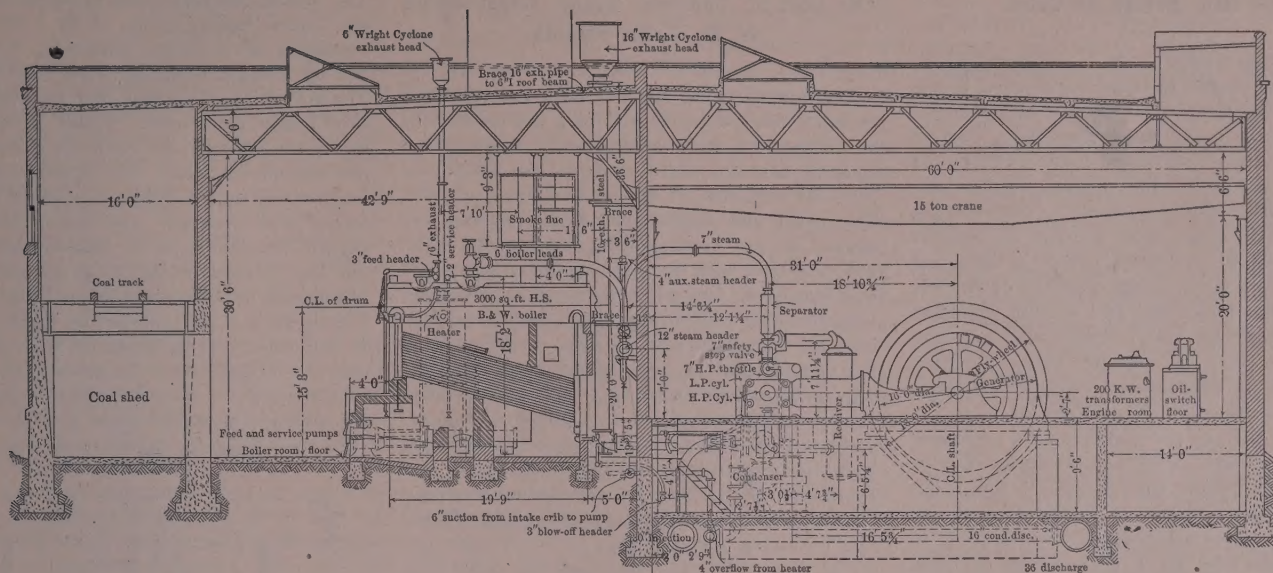
The low-pressure cylinder of each engine exhausts into a Dean jet condenser located in the operating room basement between the foundations for the high and the low-pressure cylinders. In case of emergency, however, the engines may be exhausted direct to the atmosphere through 16-in. steel exhaust mains which extend vertically from the floor through the roof of the boiler room just behind the concrete chimney. These exhaust mains are provided with the Blake relief valves located near the low-pressure cylinders and terminate in Wright Cyclone exhaust heads.

Each of the jet condensers is provided with a direct-acting air pump of the vertical type which at normal speed will maintain a 26-in. vacuum when the condenser is handling 20,000 lb. of exhaust steam per hour. Injection water, which at the rated capacity of the condenser must not be above 70°, is obtained through a 30-in. injection pipe from an intake well located 60 ft. east from the building. A 36-in. pipe connects this well to an intake crib 200 ft. out in the lake. The well, which is 10 ft. in diameter and 21 ft. 6 in. deep, is of somewhat peculiar construction. The barrel is of hollow concrete blocks resting on a cast-iron cutting edge. After being constructed above the ground it was sunk by the open dredging process and was then provided with a concrete floor and roof. The discharged water from the two condensers is carried through a common 16-in. lateral to a 36-in. discharge leading to the lake. This main discharge pipe is installed in such a manner that it can readily be extended along the head of the generator foundations for connection to condensers of units to be installed in the future.

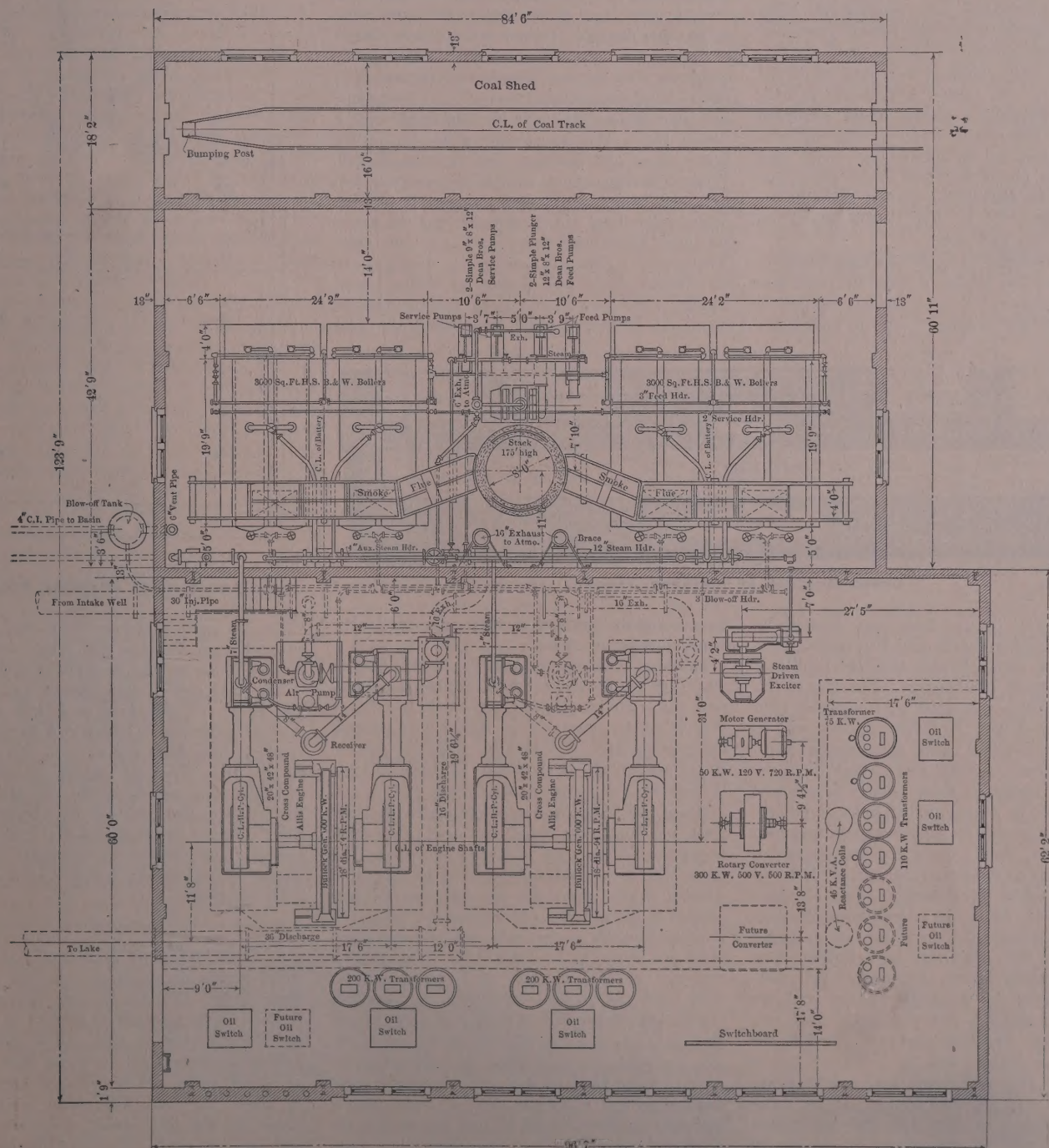
The main engines and other apparatus in the station are oiled by means of a central gravity oiling system. From a tank 7 ft. long and 2 ft. 6 in. in diameter, located just under the roof in the boiler room, oil pipes lead to the bearings of the different apparatus. All surplus oil drains through a system of pipes to a Turner gravity separator and filter in the basement of the operating room. After passing through the filter a duplex pump forces the oil into the elevated storage tank.

The station has direct track connections with the Pennsylvania Railroad and indirect connections by way of the electric line with the Big Four Railroad at Warsaw. A trestle permits steam road coal cars to be switched into the south section of the building over the coal storage space. The track enters the building through an opening provided with Kinnear rolling steel doors and terminates in an Ellis bump post. The track in the building is supported on 32-in. steel girders about 12 ft. above a concrete floor, which is at the same level as the boiler room floor. Only cars with hopper bottoms are accepted by the company, and the contents of these are easily dumped into the storage space under the track, from which it is hauled in trucks into the firing alley.

TAR MACADAM PAVEMENTS have given rather unsatisfactory service in Toronto, Ont., owing to difficulty in obtaining tar and pitch of a uniform consistency. According to City Engineer C. H. Rust, the use of this kind of pavement may have to be discontinued.



Cross Section of Power House.



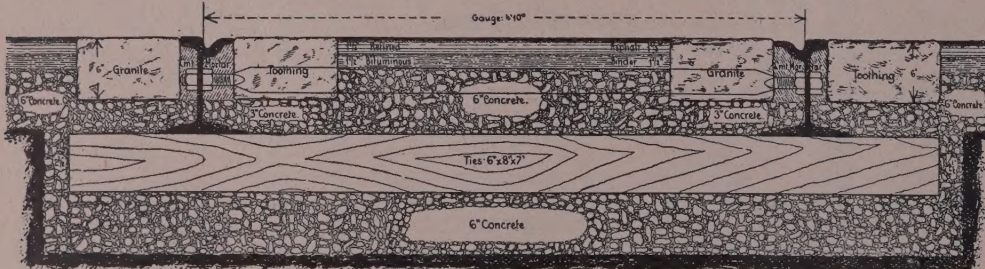
GENERAL PLAN OF THE POWER HOUSE OF THE WINONA INTERURBAN RAILWAY COMPANY.

The Nile Bridge at Cairo.

An important bridge 1,755 ft. long and 65 ft. 7 in. in clear width is being constructed across the Nile at Cairo, Egypt, to carry a 43¼-ft. highway and two 8-ft. cantilever sidewalks. Part of the roadway space is occupied by two electric car tracks for a line to the pyramids. The substructure, which was commenced in March, 1905, and finished in June, 1906, consists of concrete piers 140 ft. apart on centers, except in the center where there is a swing bridge with two 75-ft. clear openings. Each pier has two vertical cylinders 47¼ ft. apart transversely. These are made with iron sheels 12½ ft. in diameter below the river bottom, 10½ ft. in diameter above it, the lower ends being expanded to a diameter of 18 ft.

The lower parts of the cylinders were assembled on shore and were lined with concrete to give them greater weight and strength before sinking. They had a maximum weight of over 100 tons and were lowered through water up to 40 ft. in depth and sunk by a grab dredge working through central air shaft which was extended by steel cylinders so as to be always maintained above water level. When the dredging became too difficult, the dredges were removed, air locks mounted on the shafts and the sinking continued under pneumatic pressure which reached a maximum of 34 lb. The cylinders were sunk to depths of 41 to 72 ft., the caisson work being entirely executed by Egyptian workmen under European supervision. The shells were carried up to a height of about 24 ft. above low water and grillages were placed in them 17 ft. above low water to receive distributing girders and sills for the plate girder, 7½ ft. deep, which united the two cylinders for each pier.

As it was essential to avoid any obstruction to the view from the bridge, a deck structure was considered necessary. It was further required to keep the roadway within 13 ft. of high-water



Cross Section of Finished Track.

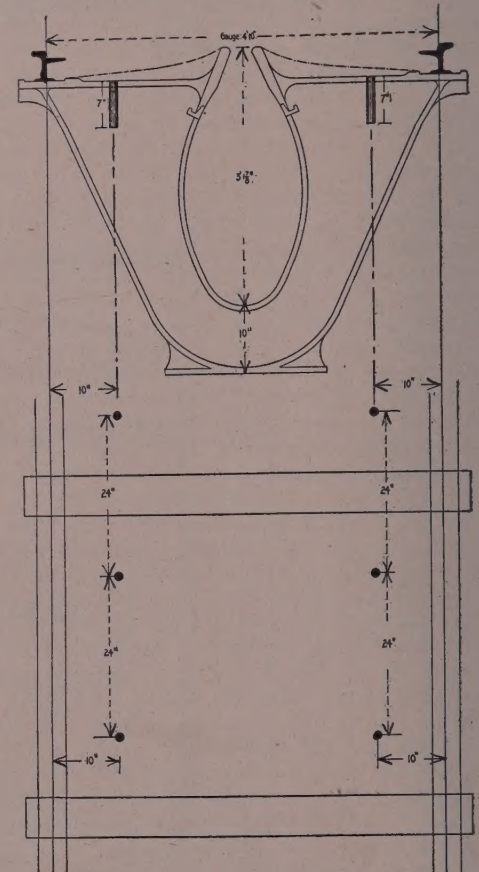
level. Headway in the river was secured by arching the bottom chords and the 140-ft. spans were made up with alternate free and cantilever girders of latticed construction. The free or intermediate girders projected 35 ft. beyond each pier, forming double cantilever girders with a continuous connecting span and leaving 70-ft. openings between alternate piers where there are center spans seated on fixed saddles at one end and suspended by pin-connected links at the opposite ends to provide for temperature movements.

Five parallel lines of girders are seated on the top flanges of the transverse pier girders and carry plate girder floorbeams, I-beam stringers and buckle plate floors, the latter having the convex side down under the car tracks and up under the roadway. The sidewalks have wooden floor plank and wooden joists. The girders are erected on falsework by a gantry traveler and are riveted by hydraulic and pneumatic machines, operated by the Egyptian workmen. Steel in the main girder is proportioned for maximum tensile stress of 5.4 tons per square inch, which is reduced 20 per cent. for compression. In the floorbeams the tension is only 4.76 tons per square inch. An illustrated description of the bridge was published in a recent issue of "Engineering."

The Cost of Concrete Track Construction in St. Louis Streets.

The reconstruction of the street railway track on Olive St., St. Louis, involving the removal of an old concrete cable conduit and the laying of a concrete base for the new track, has made possible the collection of some interesting cost data. The form and dimensions of the conduit are shown in the accompanying illustration. The concrete had been in place eighteen years and was very hard. One and a quarter-inch blast holes were drilled 7 to 8 in. deep in the concrete, four holes between each pair of yokes as indicated on the sketch. No. 2 Little Jap drills, made by the Ingersoll-Rand Co., were used. These were operated with compressed air, at a pressure of 90 lb., supplied from a motor-driven compressor mounted on a construction car. Current for the motor was taken from the trolley wire and cooling water for the compressor from convenient fire plugs. Three cars were used and ordinarily two drills were operated from each car. Although the drills were handled by common laborers, but very little mechanical trouble occurred. The blasting charges were intended to be strong enough to break the concrete into large pieces and at the same time do no other damage. In each hole a 0.1-lb. charge of 40 per cent. dynamite was used. With an electric firing machine and fulminating cap exploders twelve holes were fired at once. To prevent damage from flying rock each blasting gang used a "cover car." This was simply a flat car with a heavy floor and hanging side boards of oak. When a charge was to be fired this car was run over the twelve holes and the side boards let down. The total bill of damages for the entire six miles of reconstruction work was only \$685. There were no personal claims for damages and no window glass was broken by flying pieces, though some was shattered by the concussions. After the blasting the old rails and yokes were

The mixing machines were designed and built by the United Railways Co., of St. Louis. Each is composed of a Drake continuous worm mixer fed by a chain dragging in a cast-iron trough. The trough is 36 ft. long and fourteen men can shovel into it at once. Water is sprayed into the worm after the materials are mixed dry. In the machine first built the Drake mixer is 8 ft. long, but in the other two it is 10 ft. long. Both mixer and conveyor are motor-driven. Two slightly different types of machine are used. In one the conveyor trough is 45 in. above the rail throughout its length and in the other the trough is only 25 in. high, except just where it runs up to the mixer. The lower machine is easier to shovel into, but it must be moved forward with a ratchet and gear under the mixer, because a motor truck cannot be placed under it. The higher machine has a regular motor truck under the con-



Location of Blasting Holes.

torn up and the loosened concrete excavated to the required depth of 21 in.

The total estimated quantity of concrete blasted was 6,558 cu. yd. and the total estimated excavation was 11,410 cu. yd., or 0.348 cu. yd. per linear foot of track. The cost of drilling and blasting per mile of track was \$374.88. This amounts to \$0.353 per cu. yd. of concrete. Of this 7.6 cents is labor and 19.2 cents dynamite and caps.

When the excavation was completed the new track was laid in the trench and over it the work trains hauled away the excavated material. The track was then lined and surfaced by means of wooden blocks under the ties and concrete was tamped in place under and around the ties. The relative positions of ties, rails, concrete and pavement are shown in an illustration. The concrete was a 1:2½:6½ mixture of Portland cement, river sand and crushed limestone. The quantity required per linear foot of track was 0.273 cu. yd. The materials were distributed on the street beside the track, the sand being first deposited, the crushed stone piled on that and the cement sacks emptied on top. Care was taken to distribute the materials so there would be just enough for the work and no more. The ingredients were shoveled from the street into a mixer on the track.

veyor. A crew of twenty-seven men is required to work each machine, and under ordinary conditions 22 cu. yd. can be discharged per hour.

The total cost of the concrete per cubic yard was \$3.18. Of this \$0.26 was labor and the remainder materials. Cement cost \$1.70 per barrel, crushed stone \$0.77 per cu. yd., and sand \$0.675 per cu. yd. The total cost of concrete per mile of single track was \$4,551.36. An account giving the details of the work was read before the Engineers' Club of St. Louis by Mr. Richard McCulloch and published in the "Journal" of the Association of Engineering Societies, from which these notes are taken.

A LARGE MASONRY DAM has just been completed across the Vedavati River in the Mysore State, India. It is 142 ft. high, 1330 ft. long, 150 ft. thick at the base and 15 ft. thick at the top. It has a water shed of 3,075 square miles and impounds 224,400,000 gal. of water over an area of 34 square miles. It is provided with sluices 60 ft. above the river beds from which water is drawn for the development of electric power and will be afterwards distributed through 60 miles of canals to irrigate 25,000 acres of land.

Methods of Handling Concrete.

On heavy concrete work one of the most important items of cost is the conveying of the concrete to place from the mixer. In many instances $\frac{3}{4}$ or more of the concrete is at a low level and the mixer and bins may be put high enough to avoid elevating a large per cent. of the material after mixing. This should be done if the dry materials can be, as is usually the case, delivered economically to the machine. Inclined chutes of smooth plank may then be used. Rich grout will flow on a slope of about 20 deg., while dry mixtures require 40 to 45 deg.

When the work is of some magnitude time and money will usually be saved by installing labor-saving machinery for handling the concrete. Cableways, derricks, railways and elevators are all adaptable to certain conditions. The cost of labor and the scarcity of good men ordinarily makes the wheelbarrow uneconomical. In delivering materials to the mixer wagons and cars, or when the grade is too steep for these, cableways are used. A heavy team can haul a five-yard dump car, with ordinary bearings, weighing when loaded about 12 tons, on grades up to 2 per cent. Locomotives operate on grades up to 4 or 5 per cent.

When the area of delivery is long and narrow a single cableway may be used. An outfit of 800-ft. span, capable of handling 1 cu. yd., costs complete with boiler, hoist and stationery towers, about \$4,500 to \$5,000. Such an arrangement should handle an output of 200 cu. yd. per 10-hour day. When the area is too wide to be supplied from one cableway, derricks may be used to rehandle the material, or if the area is very wide several cableways may be necessary. Cables with movable towers are often found efficient. On long retaining walls or dams, conveying by cables, is an especially economical method.

If the total width covered by the work is a large fraction of the length a trestle and car plant may be more flexible and cheaper than a cableway. This is especially likely if the distance from the mixer to the further boundary is less than 500 ft. Assume the structure to be 100x200 ft. in plan, with $\frac{3}{4}$ of its bulk below the economical elevation of the mixer, and the mixer within 50 ft. of the near side of the work. If the concrete is less than 3,000 cu. yd. in bulk and the time limit is reasonable one mixer of 200 cu. yd. per day capacity will be suitable. The cost of a car and trestle plant, to fit the above conditions, consisting of three $\frac{3}{4}$ -yd. steel cars, two turntables, five split switches and 30-ft. trestle legs necessary for 150 lin. ft. of double track, is estimated at \$565 by Mr. Wm. G. Fargo in an article published by the Michigan Engineering Society, from which these notes are taken. This outfit should last five seasons and the timber work for several jobs. The first cost, plus 10 per cent. for repairs and renewals, divided by five gives \$124.30 as the yearly rental for the plant. This amounts to about \$1 per day for a season of 5 months. To operate the plant five men are needed, three car pushers, one man to help dump and one to operate the switches and turntables. Figuring labor at \$1.75 per day the cost of handling 200 cu. yd. in a day is at the rate of 4 $\frac{3}{8}$ cents per yard. This means, according to Mr. Fargo, a saving of about 5 $\frac{3}{4}$ cents per yard as compared with the cost of delivering in barrows. By using two-wheel steel push carts holding 4 or 5 cu. ft. as high as 100 cu. yd. per day can be handled without incurring the expense of cars, rails, switches, etc.

The Muskegon River Dam, built under Mr. Fargo's supervision, contains 13,000 cu. yds. of concrete. There the mixer was placed on the ground at $\frac{3}{8}$ the height of the concrete work. The 1,500 cu. yd. above the car track was delivered with a cage hoist on which the small tip cars were elevated to the work. At the Ceresco, Mich.,

dam, with 25 ft. total height of concrete, the car track was within 8 ft. of the top of the work, and, as the upper portions of the walls were thin reinforced-concrete, it was economical to use wheelbarrows on steep inclines, and also to shovel up to platforms. On this work the mixer and several pumps and a lighting plant in the camp were run with current secured from a nearby interurban line.

It is not practicable to handle wet concrete with belt or bucket conveyors, but the dry materials may be readily handled by such methods. Concrete cars should be of simple construction, easily cleaned, dumping at both sides or both ends as desired, and without moving parts, which will become clogged with concrete. The size of car or bucket to be used depends somewhat on the character of the work. For most building work or thin reinforced work a yard batch is rather large to dump into the forms handily and a small batch is preferable. On massive dams or heavy foundations the yard or 1 $\frac{1}{2}$ -yard bucket is satisfactory.

Book Notes.

It is rather surprising that the first good elementary book published in this country on hydraulic power development should be an English translation of a French work, for it was the American development of standard types of turbines of fair efficiency and moderate cost which, with electric power transmission, made what may be called elementary water power plants attractive commercial propositions. For some years attention has been fixed mainly on large developments, and the published information useful to the man who wishes to utilize but a few hundred horsepower is very scanty. Nevertheless there are many of these small powers put to use every year, many of them by men who would find in "The Manual of Hydraulics," by Prof. R. Busquet, of the Lyons Industrial School, just the information needed in their work. The author aims to explain the theory and design of such plants without the use of higher mathematics, and the translator, M. A. H. Peake, demonstrator in mechanism and applied mechanics in the University of Cambridge, has adhered to the same simple style. Some of the fundamental laws of fluid motion are first explained, and the flow of water in pipes and channels is then taken up. About a half of the book is a description of different types of water-wheels and turbines, and will be found a comprehensive statement of the leading features of this class of prime movers. The volume closes with an explanation of the successive steps to be taken in designing a hydraulic power development. (New York, Longmans, Green & Co., \$2.10).

A new book by Prof. Malvered A. Howe is sure to find a warm welcome, particularly when it relates to arches, a subject he has made a specialty for many years, and it is accordingly safe to predict an extensive sale of his "Symmetrical Masonry Arches," including structures of stone, concrete and reinforced concrete. To anybody who has acquired sufficient facility in mathematical work not to shy when he sees a sign of summation, the book will be very interesting, although the author might explain some of his work in a little more detail with advantage to most readers. In these days, when the demands on the time of busy men are so numerous, an author is materially enhancing the value of such a book as this if every step of the slightest difficulty is explained. This is the only criticism to be made respecting the book, which should be in the library of every designer of masonry arches. The materials and workmanship entering into such structures are so variable that working formulas and methods of

design may legitimately be approximate, and this volume is of a corresponding character; more accurate methods of analysis are given in the author's "Treatise on Arches," which those who desire to get to the bottom of the subject will do well to study. The fundamental formulas for the elastic arch are explained in the first chapter, and in the second chapter formulas are deduced for the horizontal thrust and bending moment at any point in a symmetrical arch fixed at the ends. In these two chapters the purpose of the book is kept constantly in mind and elaborate rigorous methods are discarded in favor of the approximate summation methods employed in practical design. When this part of the book is mastered, the reader is able to undertake the solution of definite problems. The first taken up by Prof. Howe is the design of a single-track railway bridge of granite, with a span of 60 ft. and a rise of 8 ft., while the second and third examples are different methods of designing a reinforced concrete arch of 50 ft. span and 10 ft. rise. The second solution is deserving of study by those engineers who look with disfavor on the method of single loads, for it introduces short methods of computation which, while not exact, are excellent working devices. The calculations are stated by the author to require but little more time than some of the graphical constructions in common use, which only give the equilibrium polygon for one set of loads. By the author's procedure it is possible to determine quickly the effect of each load and then use those producing maximum results. The final chapter of the book gives brief descriptions of typical arches, and there is a valuable appendix, on which the author has been at work for many years, containing the main data for about five hundred masonry bridges, with references to publications containing descriptions of them. (New York, John Wiley & Sons, \$2.50).

That a telegraph code comprising ten times the number of phrases and numerals given in the bulky octavo volumes of the several standard code books in present use can be brought within the compass of a book of pocket size containing only 304 pages, is quite remarkable. This accomplishment implies a radical innovation in the compilation of such codes, and in the case of the "Business Telegraph Code" this appears to have been done not only without any sacrifice, but with many attending advantages. The system is based upon the use of root and terminal code words, the former of five letters and the latter of four letters. All code words thus consist of nine letters arranged to form pronounceable syllables. This system not only conduces to great flexibility, but also admits of noteworthy condensation. The method of roots and terminals used enables, for example, all the numerals up to 999,999 to be covered in six small pages. Similarly, brief tables cover the days of each month and phrases relating thereto, days and the hours and half-hours of each day, fractions in 64ths of an inch, percentages, etc. The list of phrases embraces the entire field of commercial telegraphing, for buying, selling, prices, orders, quotations, propositions, contracts, shipping, delivery, financial matters, drawings, specifications, correspondence, erecting, insurance, railroads, steamer lines, etc. An interesting feature of the book consists of two tables covering five pages, by means of which words mutilated in transmission can be traced. Owing to the plan and the comparatively small number of code words in this system of cipher, this method enables mutilations to be in most cases easily corrected, thus avoiding the delays incident to repetition. Another important feature is that all code words are so constructed as to reduce to a minimum the probability of mistakes by telegraphers; that is to say, consecutive letters in all code words are such that when represented in the Morse tele-

graph signal code there is the least chance of mistakes by the receiving operator. Perhaps one of the most striking characteristics of the code is that its plan is such that it will serve as a basis for private codes. The special requirements of any branch of business can be met by a supplementary code which may be bound in with the general code, thus furnishing under one cover a more complete private code than would otherwise be practicable. The publishers state that they will undertake to prepare such supplementary codes for any line of business. The practical character of the code is vouched for by the experience of the compiler, Mr. Buchanan Harding, who has made a specialty of this class of work, and prior to the design of the present system prepared private codes for several of the largest manufacturing companies in this country. (Chicago, Business Code Co., \$7.50.)

A valuable book on "Alternating Current Motors," by Dr. A. S. McAllister, will make clear a good many of the difficulties which most students have in understanding these machines. It treats of single-phase and polyphase induction motors, synchronous motors and rotary converters for one, two, three, and six phases, polyphase transformations, and all commercial types of single-phase commutator motors. The object of the book is to discuss in an instructive manner the electromagnetic phenomena involved in the operation of such machines. The method of treatment is as simple as can be utilized in conformity with the accuracy required. Graphical diagrams are extensively employed, and a consistent effort has been made to explain fully all of the facts upon which the diagrams are based, while the results obtained from the diagrams are discussed at great length. Although numerous mathematical equations are found in the book, the methods of connecting each mathematical symbol directly with the physical quantity it represents and of interpreting each mathematical equation as symbolic of some definite physical relation, and of explaining each transformation in the light of well-defined physical phenomena cannot fail to impress the reader with the fact that he is dealing directly with electromagnetic phenomena and only indirectly with mathematics. Moreover, only the lower branches of mathematics are used, so that no one familiar with the fundamental facts of electricity and magnetism will experience trouble in following the treatment. The limiting of the mathematics to the lower branches has not involved the sacrifice of accuracy; on the contrary, it has allowed all errors in approximations to be definitely noted and their values to be determined. All of the errors in the graphical diagrams are pointed out and their effect on the final results are discussed. The treatment of the magnetic field in single-phase and polyphase motors is considerably more accurate than what is usually employed in discussing these machines, yet it is characterized by entire simplicity. The losses in the conductors of the rotary converters and synchronous motors for different numbers of phases are accurately ascertained in a non-mathematical manner. The simplest possible diagrams of the single-phase commutator motor are developed and discussed, after which the involved inaccuracies in the approximation are definitely determined by means of easily understood mathematical expressions. (New York, McGraw Publishing Co., \$3.00.)

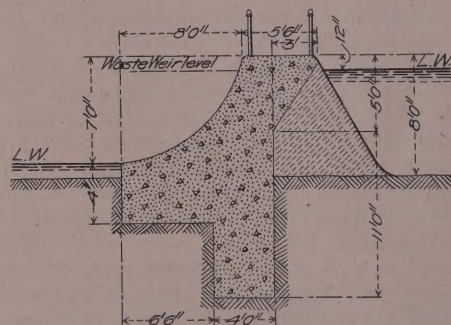
Letters to the Editor.

REINFORCED CONCRETE DAM AT DAYTON.

SIR: The accompanying sketch illustrates a new concrete dam now nearing completion at Dayton, O. It is situated on the Miami River in the northern part of the town just below its

junction with the Stillwater River. Just before the new structure is an old timber dam with rock ballast which was washed out about two years ago. Just above the dam the river had begun to undermine the levee and a row of piles was driven there to protect the bank. When the old dam broke the drop in the water exposed these piles, and it was to protect them that the new dam was built. The structure is of reinforced concrete, the up-stream side extending outward so as to give necessary breadth for a walk on top of the dam. Clay will then be filled in against this so as to give a sloping face as shown in sketch. The sketch also shows the general dimensions, the length of dam being about 550 ft. Every 10 ft. a 3-in. pipe coupling has been imbedded in the top face and 3-in. nipples will be screwed into these to hold wooden posts to support hand rails on both sides of the walk. Two hundred feet from the stairway at one end, a waste weir 50 ft. long has been built in the dam. The top of this weir is 1 ft. below the top of the dam, and during the normal flow of the river will keep the level below the top of the dam, which can then be used as a bridge. This weir is arched over with concrete slabs supported on steel beams every 5 ft. Slots are provided for drop boards to close this waste weir during cold weather. The railing will also be removed during this period and the water will then flow over the top of the dam.

A concrete stairway leads from one end of



Low Dam at Dayton.

the dam to the top of the levee on that side of the river. The other end terminates in a park which will be operated during the summer months. The dam will provide a large body of water for boating and other water sports where before there was a shallow stream that could easily be crossed by wading.

The construction was begun last spring from one side of the river and the water made to flow along the natural channel on the other side. In this way the dam has been completed with the exception of a narrow strip left open for passage of water.

The end of the dam was enclosed by a cofferdam consisting of double rows of sheet piling filled in between with earth. Near this end a large conduit 6 ft. in diameter was built in the dam and an iron gate provided. This conduit is of sufficient size to pass the normal flow of water and discharges below the apron of the dam. To complete the dam the section which is now open will be enclosed by a cofferdam and the water made to flow through the conduit until the dam is completed, when the gate will be closed and the water will rise and flow over the waste weir as mentioned before. The dam will be completed about December 1.

Yours very truly,

DAYTON, OHIO.

EDWARD BALBACH.

REINFORCEMENT OF CONCRETE SKEW ARCHES.

SIR: I will be pleased to hear from some of your readers regarding the way in which they place the steel in reinforced concrete railway structures, built on a skew. Should the bars be placed parallel to the track or at right angles

to the center line of the structure? Will some one, who has met with this same problem, state how they place the reinforcement, and give their reasons for placing it as they do?

Very truly yours,

TERRE HAUTE, IND.

GEO. L. MARICK.

[Obviously the reinforcement may be used in a number of ways. There will be little objection to placing an ordinary reinforcing rib, if such a member is used, at right angles to the axis of the arch except at the ends where some shorter members would naturally have to be placed parallel to the skew. This is not, however, the customary procedure, as is evident from the following memorandum from Mr. Edwin Thacher, of New York, who has probably had more experience in such work than any other American engineer:

"The reinforcement of skew bridges is always placed parallel to the track, the same as for square bridges and, if the skew bridge is properly designed, the stresses are made to act in that direction. We will say further that skew bridges are generally built in longitudinal sections, or as a monolith, although for square bridges we prefer transverse sections; but for skew bridges longitudinal sections appear to be the only practical way in which they can be built. The thrust in the arch should be made to act in a direction parallel to the track, which can be done by a proper arrangement of offsets in the abutment."]

A NEW HIGH-DUTY ENGINE RECORD.

SIR: Referring to your editorial on "A New High-Duty Engine Record," in your issue of November 10th, I would respectfully call your attention to the fact that the steam-valve gear of this engine is a modification of the Reynolds-Corliss, in that oil dash pots are used. These have been used by the Allis-Chalmers Co. only occasionally within very recent years on some of their Riedler pumps.

Referring to the action of the Riedler pump valves, I would say that the only difficulty which has been experienced with these valves has been a slight pounding at times, especially when the suction lift has been high. As the building of the new government dam on the Allegheny River at Brilliant will raise the water at the pumping station 10 to 12 ft. from present ordinary low water, the engine was not set as low as present conditions would have required. The dam is now nearly completed and when it is finished, the water will flow into the suction chambers of the pump.

After the engine had been operated a short time, it was found that the pounding was caused by air collecting in the suction base and being drawn into the pump in considerable quantities. The top of the suction base was tapped and a line carried to the exhaust pipe. By a very small opening in the valve in this line, the trouble from air is entirely relieved, and the engine runs very quietly. During the duty test, in order to avoid the carrying of water from the suction chamber into the exhaust, this valve was closed most of the time, and some slight pounding resulted. We find it, however, entirely practicable to run this engine by use of the by-pass, so that there is no pounding of the valves. The engine has now been running 18 months, and in that time has only been down all told about two or three days, for some slight repairs, adjustment, and for examination. During that time the leathers on two valves out of eight have had to be renewed. With the elimination of the trouble from air, the matter of the pounding of these valves is entirely one of adjustment. If the valve is brought to its seat the instant that the motion of the plunger is reversed, there should be no pounding.

Yours truly,

W. C. HAWLEY.